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ECAL X5 GIF USER MANUAL

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Abstract

This note describes the ECAL Gamma Irradiation Facility (GIF) set-up and how to identify and handle the different parts. It provides an action check list in order to avoid damage to the apparatus and to use it effectively. It describes the set-up in January 2000. A web version which will be updated when needed is available on CMS LAPP team site on LAPP web page at <http://wwwlapp.in2p3.fr/cms/GIFUSERMANUAL-X5.html>.

Introduction:

The ECAL Gamma Irradiation Facility (GIF) was built for a systematic check of radiation hardness for the PWO crystals of the CMS ECAL. It was used for the tuning of the growing technology of the Bogoroditsk Producers who requested iterative measurements for that purpose. It is used to check the radiation hardness of the pre-production crystals. It can also be used to check the stability of monitoring under irradiation. The system was designed to be able to use various photodetectors like PMTs or APDs relevant to the CMS Project. The set-up can benefit from being installed at the end of the X5 beam line at CERN and can compare beam effects and source effects. Some technical details will be provided in this note to allow new users to get an overview of the system quickly and to handle it more

efficiently.

I THE SET-UP: The ECAL X5 irradiation facility is located at the end of the X5 beam line at CERN in experimental Hall 180.

1 THE EXPERIMENTAL AREA:

1.1 The irradiation source

The source is a Cs ¹³⁷ source of 740 GBq (installed from March 5th, 1997, the period is 30 years), it is the kernel of the General Irradiation Facility and is shared by different teams. It provides two irradiation holes on two axes at 90° to each other. The general geometry of the set-up is summarized on **Fig 1(a)**. More details can be found in Ref. [1]. Principles of operation and typical results are described elsewhere [2]. It is also useful to consult the Web site <http://nicewww.cern.ch/sl/eagroup/irrad.html>

The experimental set-up is made of an irradiation box mounted on a moving table which allows a set of crystals (usually 3 or 5 according to the photo-detectors used, Philips XP2262 or, PM Philips XP1921 or APD) to be irradiated almost uniformly, from the side. The geometry adopted allows crystals to be irradiated almost uniformly on a width of 18 cm at an irradiation rate close to 15 rad/h. It is possible to move the crystal remotely in the beam line to check the irradiation effect on the transmission of light produced in the crystal by particles or to carry out other detailed studies.

Muons are usually available when the X5 beam is running upstream in proper conditions. Electrons are also available for dedicated runs when required by us as main user of the X5 line (see **Appendix 8**).

1.2 The hardware arrangement

The scheme of the table with irradiation box is shown in **FIG 1(b)** and a picture of the set-up in **FIG 1(c)**. As shown in **FIG 1(a)**, the beam line is at 1.26 m above the floor and crosses at 90° the axis of irradiation used to install the so-called irradiation box. The irradiation axis is at 0.65 m above the floor and the irradiation solid angle is limited in this direction by a full width collimator of 20°. This peculiar situation has required the installation of the irradiation test box on a table equipped with a remotely control led vertical movement in order to be able to reach the beam axis with the crystal set, for control checks during a continuous irradiation. The table is a commercial one, with hydraulic vertical movement powered by a battery. The table top has been equipped with an aluminium box containing the crystal set to be irradiated, the lead shielding required by the protection of the photodetector blocks, and quartz fibre bunches used in the test. The box can be driven by a remotely controlled movement along the irradiation axis in order to tune to some extent the irradiation rate and to push the box in proper position to reach the beam line when required. The complete set-up table with box can be easily rolled out by hand from the irradiation area in order to change the crystal set and to proceed to electrical and electronic tuning before going to the irradiation area.

A moving plate supporting a massive copper temperature regulator with crystal shelves attached, the lead shielding, and the different combinations of photodetector blocks is installed inside the box. This is required on account of tight mechanical constraints when sharing the space with the filters mechanism shown in **Fig 1(a)** which does not allow the crystal set to be fully aligned on the irradiation axis just by installing the table as close as possible to the filters.

Figures 2(a) and Fig 2(b) describe and show the main part of the set-up inside the irradiation box. **Figure†2(a)** shows the set-up in the latest version during the work for tuning crystal technology as described in Ref.†[2]. Other possible arrangements are described below. In addition, two monitor channels shielded from the radiation are installed behind the main copper cooler.

Three bunches of fibre optics are installed inside the box for different purposes. Two of them are made with 10 quartz fibres of 200 microns fitted in a plastic AMP connector, one is single 200 micron fibres mainly and used with the laser light (see below) with a ferrule connector of 2.5 mm in diameter. They are connected to various external light sources (Xe spectral lamp with remote controlled monochromator, stabilized LED, current training LED, laser).

Since the light output of crystals depends on temperature, temperature sensors are spread inside the box to monitor the temperature of air inside the box and near the crystals.

All electrical connections (HV, pulses etc). and fibre bunch connections to light sources are made through metal-injected boxes external to the main aluminium box which supports all the connectors for electronics or light boxes.

1.3 The Light source

The basic measurements rely on the transmission loss monitoring of light with various wavelengths injected through the crystals during their irradiation. This implies stable enough light sources and gain monitoring of photodetectors, specially with PM, for precision measurements.

a) **The lamp source:** This is a wide-spectrum lamp [Hamamatsu [L2437]] coupled to an optical system, with a grating remotely controlled through CAMAC. It provides through an optical fibre bunch a set of chosen wavelengths used in a cycling way at the end of the crystal. The transmission loss versus wavelength is monitored in a continuous way during the irradiation measurements [3].

b) **The stabilized LED [4]:** A stabilized LED gives a pulsed blue light at 465 nm with a 0.2% output stability precision is used in order to monitor the gain of the PM and of monitor channels of the set-up.

c) **Current LED:** A second LED, called Current LED, is installed at the entrance of the fibre bunch and coupled to the stabilized LED box, it is used to stabilize the gain of photodetectors when photomultipliers are used as detectors, by providing a mean current to the PM photocathode before irradiation roughly equivalent to that during irradiation under the scintillating crystal light.

d) **A dye laser source:** Is also available, it allows one to make tests with another geometry of the injected light closer to the real monitoring fibres foreseen for CMS. A stabilizing system has been developed to maintain the mean output light pulse within 0.25% [5]. Another possibility of UV light is to excite the photoluminescence of the crystal directly and to thus obtain an isotropic light-emitting source inside the crystal.

1.4 The temperature stabilization system

The temperature stabilization is done with temperature regulated water from an external tank and a bio-block polystat 44 unit insuring the heating and the circulation through a separate cooling unit and through the system inside the irradiation box. The cooling set-up is shown in **Fig 3(a)**. A system of valves [**Fig 3(b)**] allows the temperature in the box to be regulated through the tank with a low circulating pressure. The tank can also be bypassed. In that case, the box can also be cooled with water taken directly from Lake Geneva. This configuration allows the cooling system to be filled at the proper water level and the air in the system to be expelled if needed. The proper positions of the various valves are shown in **Fig 3(c)**.

1.5 The temperature sensors

The temperature sensors are AD 590 protected from the radiation behind the lead shielding.

1.6 The photodetector blocks

Different possibilities for photodetector blocks have been foreseen.

a) PM blocks

1. A block with three PMs type Phillips XP2262 or XP2020 may be used with direct coupling to the crystal with optical grease (it has been foreseen to be used for muon beam conditions if necessary) [Fig 4(a)].
2. A block of five PMs type Phillips XP1921 may be used with coupling to crystal with optical grease through a quartz light guide. (as this PM is smaller than the crystal output area, the light guide allows the gain monitoring light of the LED box to reach the PM) [Fig 4(b)].
3. A block of five PMs type Phillips XP1921 looking at the crystal light through aluminized mirror at 45°. This mounting has the advantage of keeping the detected signal free of any bad optical contact and of allowing an easy removal of the crystal. The PM mountings are sketched in Fig 4(c). The mechanical constraints of the set-up require to install crystals with PM readout in such manner that if particles are used they enter through the back face of the CMS crystal (the larger one) and have to go through PM before to reach crystal.
4. The beam particle tagging block: except for the three PM block above, all the others can be installed with the tagging particle block which consists of five XP 1911s coupled to 20 x 20 mm square scintillators in front of each crystal under study to tag the particle beam crossing along each crystal when the crystal set is moved to the beam line. This block is sketched in Fig 4(d).

b) The APD block

Thanks to the small thickness of the APD capsule, connected to the pre-amplifier through a small cable, an APD-detector block was built allowing the use of the beam with the crystal in the standard way. (See description in **appendix 1**). It is currently connected to the electronic board used by the PROTO-98 of the CMS electronic tests.

1.7 The monitoring of the set-up

As stated above the stability of the light source has to be monitored as well as the gain of the different channels involved in the measurement.

For the use of the PM blocks, monitoring is made by two special channels inside the box (empty tubes with Mylar reflectors without crystal) with the same type of PM as the detecting ones and looking at the stabilized blue LED light through a fibre. Others fibres feed the channels with the light of the lamp. Outside the box, LED light is also monitored by a p-i-n diode unit. All these units are situated behind the massive cooler with an extra lead shielding to ensure their protection from the radiation source [Fig 5(a)].

A special unit was made for use with the APD block, with two APDs of the same type as the measuring ones. Laser, LED and lamp light are distributed through a bar of quartz which is also seen by a PM 1921. Light emitted by an americium source through a small YAP crystal [6] is also used as a reference. Finally, a possibility to monitor the laser in UV mode through the detection of the photoluminescence of a small slab of PbWO₄ is also provided [Fig 5(b)].

1.8 Cable Pass and connection panels

The system was designed to be used in two places: inside the irradiation area, and outside to change the crystal set to be tested and to check and tune all the channels before going to the irradiation area. This minimizes the interruption of the irradiation source for other users.

For this purpose, two patch panel stations were installed, one inside the irradiation area, one outside. Most of the cables outside the irradiation box were grouped into bunches with Burndy connectors of different sizes to avoid confusion and are labelled. The connections inside the box are made through standard SHV and BNC connectors. Temperature probes are read through a 3M 20 contacts connector. Special pin-outs for the temperature probe connector and for pulse cable connectors are described in

Appendix 5.

II THE COUNTING ROOM AREA

1 The Electronics of acquisition

The two electronics racks are shown on **Fig 6 (a-c)**. On the scheme, one sees the map of the main pulses which send the remote control signals and the map of the main reading and trigger units

2 The data acquisition system

The data acquisition system is developed in the standard Labview framework which make it transparent for any Labview expert and easy to modify and upgrade. The current version use a National PCI-VME Interface and a VME system connected to a CAMAC crate through a VME CAMAC interface. The trigger system supports 6 different types: the PED (pedestal), LED, LAMP, LASER, BEAM and TestPulse. They can be mixed in arbitrary manner. When beam is present, the other triggers are not allowed. When they are allowed, they are independently free running with a rate low enough. The trigger logic schemes are sketched in **Fig 7 (a-e)**.

The GIF DAQ consist of:

- A PC (Dell Pentium II 233 Mhz, 129M memory);
- PCI-VME interface (National Instrument MIX-II);
- VME-CAMAC interface ();
- LabView software.

The system provide events readout and saving on the local disk. The readout time including disk writing is less than 2.5ms per event.

The system provides also some minimal on-line control: amplitude spectra and stability graphs for each ADC channel, temperature stability graphs, TDC values distributions. There is a separated set of graphs for each trigger type. But as the data manipulation tools are rather poor in the standard LabView, a more powerful control is done by a task running on Unix work station connected to the DAQ via generic LabView software socket.

2.1 Cold start of acquisition

The computer is supposed to be on.

Two icons have to be used successively in the following order

1. DAQ_gif
2. mono_scan

1. Click on DAQ_gif twice, it will proceed to the needed initialization (CAMAC etc). and will start all the LabView software needed.

Which are DAQ_gif.vi

375_draw.vi, 420_draw .vi, 500_draw.vi, 600_draw.vi, 660_draw.vi,

PED_draw.vi, LED_draw.vi, TEMP_draw.vi, Beam_draw.vi

A window is automatically opened for each process. To put them in stand-by mode on the bottom line click on the \bar{n} sign on the top right corner of each window. (If you close the window by error see remark below).

2. Click on the mono-scan icons in the desktop, you get a window opened by the light source control program. It contains a table with the wavelengths to be set and a

timer per position field which defines the time in seconds that the source had to spend in each color position.

The color scan is automatic, independent of the data acquisition system; once started this panel does not require attention.

Remark: go to my computer c:\Labview/gif/vi directory, all vi are there click, on the one you closed by error it will be set on again.

2.2 Display windows

DAQ Control Window: it appears on the screen after a DAQ general start. It is shown in **Fig 8(a)** and contains five fields:

□---- **RUN control field** with buttons to START, STOP and PAUSE the run. The EXIT button allows the DAQ to be stopped and the **RUN number** field has to be filled in at the start of DAQ, it is automatically incremented at each START of run.

---- **EVENT display** has separate fields for event header, eight ADCs, 10 temperatures, eight TDCs and five scalars. The ON/OFF button can be used to make the display fields visible/invisible. The event header displays the run number, the time, the event number from the start of run, and the trigger types (see below).

Note that due to the bad time sharing under Windows, running an event display leads to an increased dead time from about 1.5 ms/event to 10 ms/event. So, the event display should be OFF during normal data taking.

---- **On-line control field.** This provides a monitoring ON/OFF switch, an ADC channel selection, a trigger type to be monitored selection, an ALL histograms reset button. When the analysis switch is ON, a vector of several events, the number of which is being defined by the **Events for mean** parameter, is analysed by the appropriate procedure after separation by trigger types according to the trigger types selected in the **DISPLAY** field. Each analysis routine has a separate display window where information corresponding to one ADC channel is displayed. The ADC channel selected in the ADC selection field is the same for all display procedures. Note that histograms are filled for all ADC channels, but only one channel is displayed at a time.

---- **Data sampling** field controls the data sampling to a remote workstation for an extended on-line control. If the **sampling** switch is ON, a software link with the computer at the IP address selected in the **Host name** field is established. Details of this part of the on-line analysis will be described in a separate note.

---- **DATA recording** field controls the local data recording. When **Write file** is OFF, data are not recorded at all. Otherwise they are written in binary format to the file `irunXXXX` where XXXX is a run number, in the local directory defined in the **DATA path** field. The current opened file name is indicated in the **DATA file name** field. If an error occurs during the file open/create or write operation, it is indicated by three indicators at the right bottom part of the field. When one of the indicators is on, the run is stopped.

Stability control panel (for PED, LED, lamp, laser [**Fig 8(b)**])

This window presents a series of fields, the meaning of which are straightforward.

Nevertheless, it should be noted that the stability chart at the right receives a new point after each N events defined in the `event for mean` field of the DAQ-control window. So the abscissa is proportional to time but the unit depends on the conditions stated for the acquisition rate.

The histogram at the left represents a projection of the chart on its right. Note that the number of bins is always 1000 and that the values are defined by the `imin` and `imax` field above.

A clear button exists independently for the chart and the histogram.

Beam window control [(Fig 8(c))]

The signals from the drift chamber from the beam line are available in the electronics and decoded through the TDC. The two big right histograms display the x and y profile of the beam on the chamber 1.5 m in front of the crystal when they are placed in the beam line. (The set of chambers are labeled DWC 214 and DWC217).

On the left a set of five histograms displays the signal amplitude in each crystal in the same geometrical order as the crystal in the box (the top one is number 1, the bottom one number 5). In the **Fig 8(c)** a 50 electron beam is shown in the central crystal and pedestal signal in the others four.

Temperature stability control [Fig (8)]

It displays the temperature variation of the temperature probes in the box, normally the probes are compared with each other and a proper correction introduced so that they give the same indication for the same temperature. If you change a probe, it has to be readjusted in accordance with the others and the constant coefficients have to be re-tuned in the program.

2.3 Data format

The data format appears in the event display and is made of 36 words I4 (32 bits integer) which have the following meaning:

Words 1-5 Header: Run number, time, event number, trigger type*, pattern unit

Words 6-13 ADC 1: 8 ADC channels 1-8

Words 14-23 Temperature channel: 1-10

Words 24-31 TDC channel: 1-8

Words 32-36 Scalers channel: 1-5

*The trigger types have the following meaning: 1 - PED, 2 - LED, 3 - electron, 4 - Testpulse, 5 -Xe lamp 375, 6 - Xe lamp 420, 7 - Xe lamp 500, 8 - Xe lamp 460, 9 - Xe lamp 400.

III HOW TO INSERT OR REMOVE CRYSTALS FROM THE IRRADIATION BOX

Crystals are supported in the box on removable crystal shelves, the upper part of the shelves being adjustable to fit the various crystal dimensions.

BEFORE OPENING THE BOX BE SURE THE HV AND BOOSTER ARE SWITCH OFF IF PHOTOMULTIPLIERS ARE USED.

SWITCH OFF POLARIZATION OF APD AND PREAMPLIFICATOR POWER

SUPPLY.

BEFORE INSTALLING CRYSTALS AS DESCRIBED BELOW

BE SURE CRYSTALS HAVE BEEN WRAPPED IN TYVECK PROTECTION OR SIMILAR

(see also **Appendix 6**)

- **1** The table with the irradiation box is moved out of the irradiation area, take special CARE of the fibre optics bunch for the lamp which is disconnected from the irradiation box.
The pulse cable bunch (grey) and the HV cable bunch (red) are kept with the box and must be disconnected from the pulse cable bunch and from the HV distribution box, respectively.
- **2** Removes the isolation box.
- **3** Be sure that the screw which maintains the set-up in position during irradiation inside the box is **FULLY UNSCREWED (Fig 9)**.
- **4** Open the box as indicated in **Fig 10**.
- **5** Figure 11 (top view) shows the set up inside the box.
 - a) Remove the two screws no.1, slide back the PM support and turn it to one side.
 - b) Slide the crystals back one by one in direction 2.
 - c) Unscrew no.3 and slide it back to free the crystal shelves.
- **6** Looking at the shelves as from the side, it can be seen that four screws maintain the shelves against the copper block cooler (**Fig 12**). Unscrew them and remove the shelves vertically as shown in **Fig 13**.
- **7** Once you have removed the shelves, install the crystals on them. According to the type of crystals be sure that the rectangular faces as indicated in **Fig 14** are put down on the shelf.
- **8** Install the set of crystal as shown on **Fig 15**. Each brass part is fixed to the back of the main copper plate by two screws*.
Install each crystal on the fixed part of a shelf, with the crystal end fitting the edge of the back plate.
Fit the brass part to the top of the crystal and screw it firmly from the back.
Remove the crystal.
Repeat the sequence with each crystal and remember where they fit on which shelf in order to put them in place later after reinstallation of the shelves.
***WARNING:** don't try to replace any of these screws with similar ones from the shelf, their length has been specially adjusted in order not to damage the crystal.
- **9** Reinstall the shelves by proceeding through 8, 7, 6.
- **10** Insert the crystals at their respective position. Once properly installed, they should project beyond the shelves out by 1 cm towards the PM side (or PM or APD according to the chosen detector, see below).
- **11** Properly adjust the photodetector block used (see above photodetector block paragraph).
- **12** Close the cover of the box.
- **13** Screw the screw on the box side, up to the end (**Fig 9**).
- **14** Check that you have all signals from the LED and through the lamp channel (use the auxiliary LED box for this last test).
- **15** Put the isolation cover back.

- **16** In principle you are now ready to go back into an irradiation area.

IV MOVEMENT TO INSTALL AND REMOVE THE TABLE FROM THE GIF AREA

Figure 16 summarizes the movements to move the table into the irradiation area.

Successive positions are ordered by number. Proceed in reverse order to go out of the area.

WARNING:

The two most delicate points are when you go through the door; be very careful at points A and B on position 1.

When you go to position 2 the weight of the table pushes it against you and towards the concrete block.

Be sure you are straight in the rails up to the end of position 6 AND block the backside right wheel (green button).

V INSIDE THE IRRADIATION AREA

You arrived there thanks to the movement described in **Fig 16**. Now you have to reconnect the cables and the optical fiber bunch carefully before proceeding to the irradiation.

All cables are labelled and must be connected in the proper place.

- Pulse cables (Big Burndy grey cable) to Burndy cable labelled "pulses" along the concrete block.
- HV red cable bundle to the HV box distributor mounted on the concrete block.

These two pieces of cables must always be kept connected to the irradiation box to allow the test and tuning outside of the irradiation area.

- Connect the flat cable of the temperature probes.
 - Connect the LED drive cable to the LED BOX.
 - Connect the cable labelled "start led" to the start of the LED BOX.
 - Connect the "Current LED" cable to the corresponding cable going to the input of the fibre bunch.
 - Connect the 4-pin Burndy cable labelled "Table" to the Burndy connector on the right side of the table near the local up/down movement button.
 - Connect the motor cable to the motor of the longitudinal movement of the box on the table.
 - Finally, connect the quartz fibre bunch to the proper place with the "Leybold type" connector and check that it slides in order not to be damaged during the movement of the table. Be aware, when you fix the position of the connector and of the fibre bunch, to mount them as shown on **Fig 17**. Check that movement of the table is OK and that NO cables OR FIBRE BUNCH will be damaged by the table movement.
- For that:

Note that the table can be moved up **only** when the irradiation BOX has been pushed at the end of the table by the motor of the longitudinal movement when the table is down in position for irradiation. The irradiation source axis is at 65 cm from the floor as shown on **Fig 1(a)**. In addition to this safety

element to avoid any damage to the filter system of our colleagues of the muon community, check with the TV during the remote movement that all is going well.

Move the table with the red and green buttons on the longitudinal movement motor drive, to the far end position (close to the source).

Check with the local up/down button that the table can move up in the beam line without damaging the cables or fibre bunch.

Come back to the irradiation position. (The farthest position from the source).

Later, all these movements will be done remotely from the counting room during the irradiation period.

WARNING: When you proceed to IRRADIATION be sure to close the shutter before starting to move the box towards the source, otherwise you will increase the dose irradiation by a factor 4 during the movement.

[1] S.Agosteo et al. CERN EP-2000-031.

[2] CMS NOTE 1999-061.

[3] A.Singovski et al. CMS technical NOTE in progress.

[4] A.Fyodorov et al., Nucl. Instr. Meth. A 413 (1998) 352-356.

[5] A.Fedorov et al., Submitted to Nucl. Instr. Meth.

[6] Masaaki Kobayashi et al., Nucl. Instr. Meth A 337 (1994) 355-361.

APPENDIX 1: THE APD BLOCK

This **appendix** describes the APD detector block and its connection to the system instead of the PM block generally used for irradiation tests. This block allows one to combine irradiation by source and tests with the electron-beam coming from X5, with electromagnetic shower development as in the CMS detector. With this set-up, studies associating beam and monitoring may be performed.

To use the APD block as a detector, the PM block is completely removed and is replaced by another block, which can support fibres optics and a temperature sensor system mounted on a spring mechanism for each channel individually **[Fig 18(a)]**. The spring mechanism also ensures the pressure on the APD cell detector through an optical coupler in gel form (usually Dowcorning 3001) at the other side of the crystal.

The shelf cooling block has to be removed to prepare it for receiving crystals like the PM, but this time the largest output face of the crystal must be opposite to the previous mounting (opposite to the fibre block for the lamp).

The plate with the two control channels on the back of the massive cooler block has to be removed and replaced by the special T-shaped cooler plates system on which the preamplifier boards for APD will be mounted **[Fig 18(b)]**.

Special flat cables are provided to feed the HV power supply for the APD (white connectors) and the preamplifier power supply (small black connector). Board A on **Fig 18(b)** is for the APD control channel and board B is for the five channels under test. The signal are extracted through five Lemo connectors. A sixth connector is devoted to the input of a calibration signal (see **Appendix 2**).

Once the electronic board B is mounted on the cooling flange, a special lucite piece is fixed on the cooling flange to receive the fixing screw of the APD cell holders **[Fig 18(c)]**.

APD cell mounting: each APD cell is mounted on holder with two guiding screws.

- 1) A 10 mm diameter nylon screw 25 mm long which allows one to push the cell against the crystal to provide a good optical contact (with optical grease).
- 2) An AD590 temperature sensor can be mounted against the output crystal face by screwing it on the cell holder with a bronze-beryllium spring.

Each cell must be connected to the central connector of the board in the proper order as indicated on **Fig 18(b)**. Recommended connection order is the following: channels 5, 4, 3, 1, 2.

The APD cell is made of the original piece installed in a counter piece with a needle screw, this allows one to exchange the APD cell easily in case of defect. The counter piece can support a fibre bunch specially designed to allow tests with a fibre coming from the detector side instead of from the opposite side.

APPENDIX 2: TEST PULSE FOR APD PREAMPLIFIER

The sixth connector (see **Fig 18(b)**) of each preamplifier board is devoted to a test pulse. A common test pulse is sent to the two boards in the box through a splitting with a (T) Lemo connector. The present test pulse is made of a negative pulse with 1.24 V of amplitude and 4 μ s duration (a sufficient duration has to be set up in order to take into account only the negative part of the differentiated pulse on the board).

APPENDIX 3: LED BOX TUNING

- 1) The LED box is started by a new trigger pulse of 100 ms width. Firstly check that the start pulse is OK on a 50 Ω scope input.
- 2) The LED box has a V ref. output Lemo connector and a monitor output Lemo connector. A feedback fibre has to be put on the box to get a monitor signal. Now use the high impedance input

of the scope. Adjust the monitor signal in the 2-3 volt range with the help of the gain buttons (if you cannot check that, the optical fibre used is damaged or of bad quality).

The monitor pulse moves on the scope between a minimum and a maximum amplitude.

Adjust the Uref in the middle of this range with the potentiometer near the Uref output (a small screwdriver is needed).

The monitor signal should regulate around that value and the control LED on the box now flashes regularly.

APPENDIX 4: CURRENT LED TUNING

The pulse amplitude is set to 3 V and its width to 10 ns with 15 ns between the pulses for a standard setting-up.

APPENDIX 5: TYPICAL PARAMETER TUNING

TYPICAL TRIGGER RATE

Recommended trigger rates as follows:

PED: 10 Hz
LED: 10Hz
LAMP: 20 Hz (to have enough statistics per wavelength)
LASER: 10 Hz (to save present laser life)
BEAM: able to handle 900 events/burst

TRIGGER TYPES

The different triggers are sent to a 16 register pattern unit on the following bits:

1	PED	10	
2	LED	11	
2	ELECTRONS	12	
3	TEST PULSE	13	
4	LAMP	14	
5	LASER	15	BURST
6			
7			
8			
9			

How to proceed to an irradiation

A) With the PM 1921 block:

- 1) HV is on at 1270 volts.**
- 2) Switch on the boosters.**
- 3) Start the LED and the Current LED (check the rate).**
- 4) Start the run.**
- 5) After some hours of current training (at least 10 hours).**
- 6) Switch off the current LED and open the shutter for irradiation.**

B) With APD: Set the APD HV. (It has to be in a Nim crate not too far from the irradiation zone and is usually put below the cooling system support. Start the run for stabilisation (24 hours). Then you can proceed to irradiation.

APPENDIX 6: Troubleshooting

THE COOLING SYSTEM

The cooling system is made from a copper block through which thermo-regulated water circulates. A fast fluid connector allows one to interrupt the circulating tube and to isolate the box part and the pumping part from each other. Be careful that the loss of fluid from the tank, when moving the box inside or outside the irradiation area and that you are obliged to disconnect, is not too big, and complete the level as indicated, otherwise the pump stops and the temperature of the irradiation box will not be regulated.

The cooling system has been built with the possibility to use outside an water source under standard pressure to bypass it or to fill it with water or to purge the system from air when it was stopped for too long.

The different valves, labelled on the panel, have to be used according to **Fig 3** and the associated table.

Troubles: Sometimes water no longer flows through the system when the cooling part is running for too long without interruption (some weeks). To cure the problem, switch off tank regulation for one night, meanwhile use the standard water flow to make an approximate regulation.

The connector Pin-out

Temperature sensors: Temperature sensors are red with a flat cable equipped with a 20-pin 3M connector. Pin-outs are shown in **Fig 19 (a)**.

Pulse cable Burndy connector: Signal pulses from the PM or APD are sent to the counting room by a bunch of 16 cables with a 48-pin Burndy connector. The pin-out of the male connector on the cable bunch is shown in **Fig 19(b)**.

Booster cable pin-out: The pin-out of the booster cable is shown in **Fig 20(a)**.

Grounding precautions

To avoid unwanted grounding loops between APD board and external metallic cover, isolation should be foreseen between the detector block and the aluminium box.

Critical points are the spring system of the detector block movement inside the box and the top of the cooler box.

Input attenuator box

The pin-in of the attenuator box is shown in **Fig 20(b)**. The attenuator can be inserted on pin 1, 2, 3 or 4, 5, 6 respectively. If only one attenuator is needed, use pins 4, 5, 6 as indicated on **Fig 20(b)** and short-circuit pin 1,†4. If no attenuator is needed just short-circuit pin 3, 6 then other pins are not used.

Lamp wavelengths

Normally, for each wavelength, the stability plot display different signal level (right part of the stability display). If that value does not change, that means that the scanning of the lamp monochromator is not running properly. Check the step motor unit of the monochromator, only the indication LED in the middle should be on.

If the right or left indicating LED are also on, the end of course has been reached. Call the GIFCMSECAL responsible person.

Crystal wrapping

To protect the crystals from hard contact with metal, they have to be wrapped some material. For current use, we have decided to wrap them with Tyveck pieces easily removable with a Velcro type lock.

APPENDIX 7: SOURCE RATE AND PROFILE FILTERS

Usually the irradiation takes place at a standard distance from the source for the crystals. The distribution of the rate in front of the crystal shelves, measured without crystals with a matrix of TSL

probed for 30 minutes and given in rad/h is given in the **Fig 21(a)**, the mean integrated value deposited in the crystal versus the position is given in **Fig 21 (b)**.

In front of the crystal, on the source side, a PVC box is used to keep the geometry between the lead shielding blocks. It may be replaced by a copper box with lead filter shaped to mimic the damage profile made by a 100 GeV electron electromagnetic shower.

APPENDIX 8: INSTALLATION WARNING FOR OPERATION WITH BEAM

To use the beam, it should be kept in mind that due to the mechanical constraints of the set up, the beam on nominal X5 axis position cannot reach the column of crystals. Before to use the beam, delay wire beam chambers and vacuum tube have to be moved by 100 mm toward the Jura. With Trim 3 and 4 of the beam line, beam is moved on the counter S2, the position of which is given in **Fig 22(a)** with respect to the concrete shielding blocks just after the last delay wire chamber before the crystal box.

The frame supporting S2 has on its top a scanner which allows to install a lead glass in order to check the quality of the electron beam. Once tuned, the lead glass can be remotely moved away from the beam line to start the check of the beam position in each crystal. Movement command is on the position 7 of the longitudinal movement box [**Fig 6(a)**].

Vertical positioning of the crystal column is marked by an arrow's position in respect with a line mark on a standing piece installed on the nearby filter frame used for the forward irradiation by the muon community. This arrow is fixable on the isolation cover [**Fig 6(b)**].

The arrow position can be checked in the counting room by TV monitor. In addition for a more precise and visible position adjustment, a bar with holes is passing in front of a red LED. This bar is fixed on the top of the isolation cover. As for easily and quick dismounting purposes these elements, arrows and hole-bar, are mounted with a Velcro type system, checking of the positioning have to be done before each irradiation starting when the system is reinstalled after crystal loading.

POSITION AND ORIENTATION OF BEAM, SOURCE AND FILTERS
IN GAMMA IRRADIATION FACILITY (ZONE X5C)

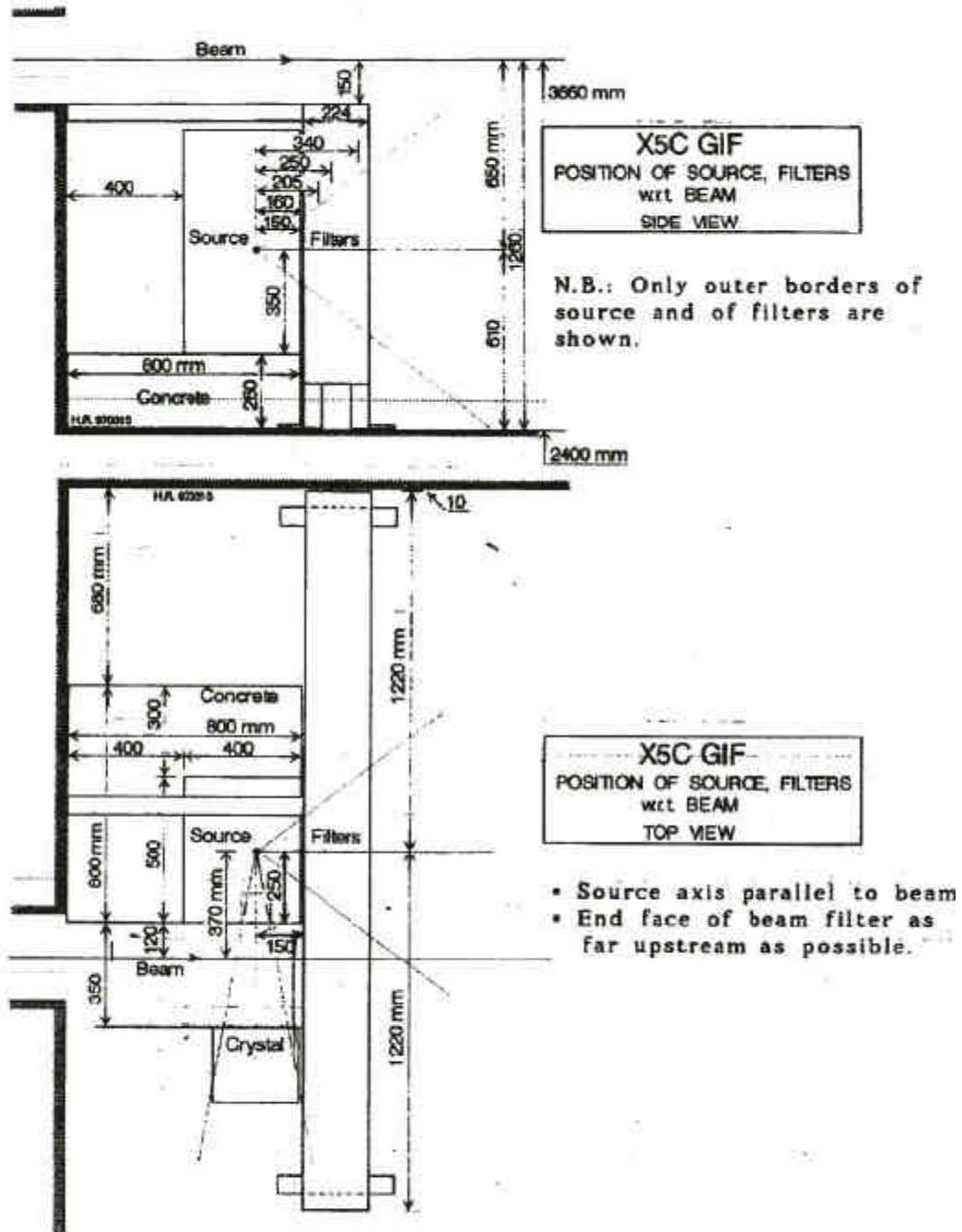
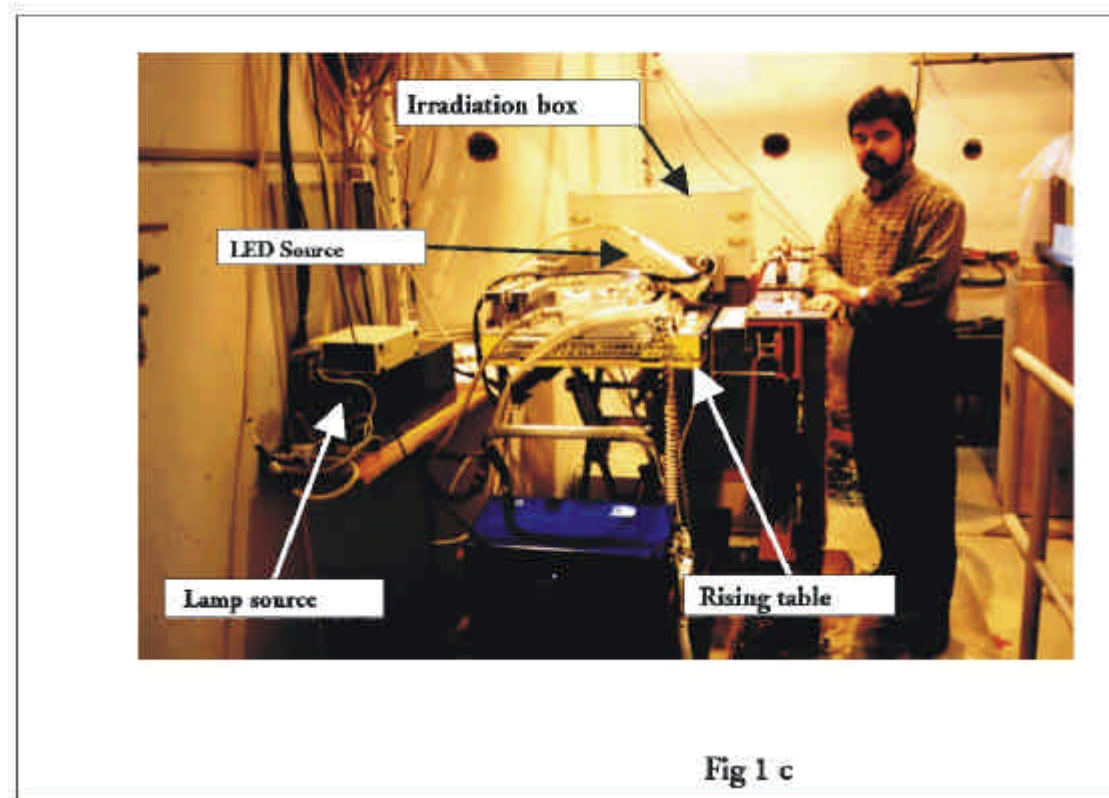
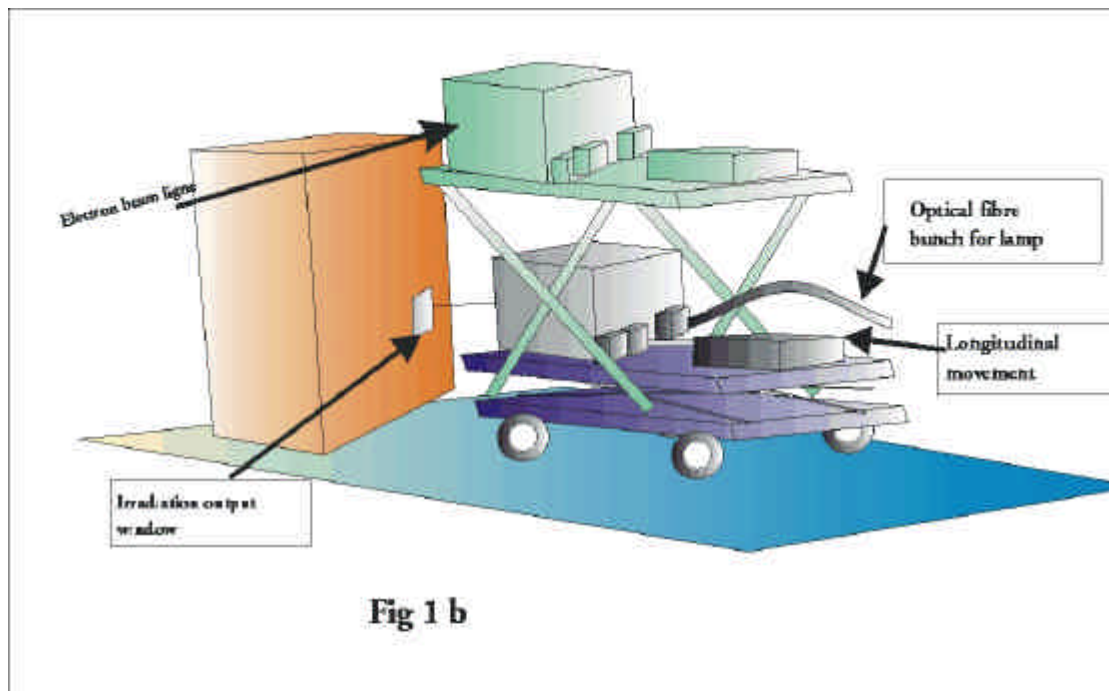


Fig 1 a



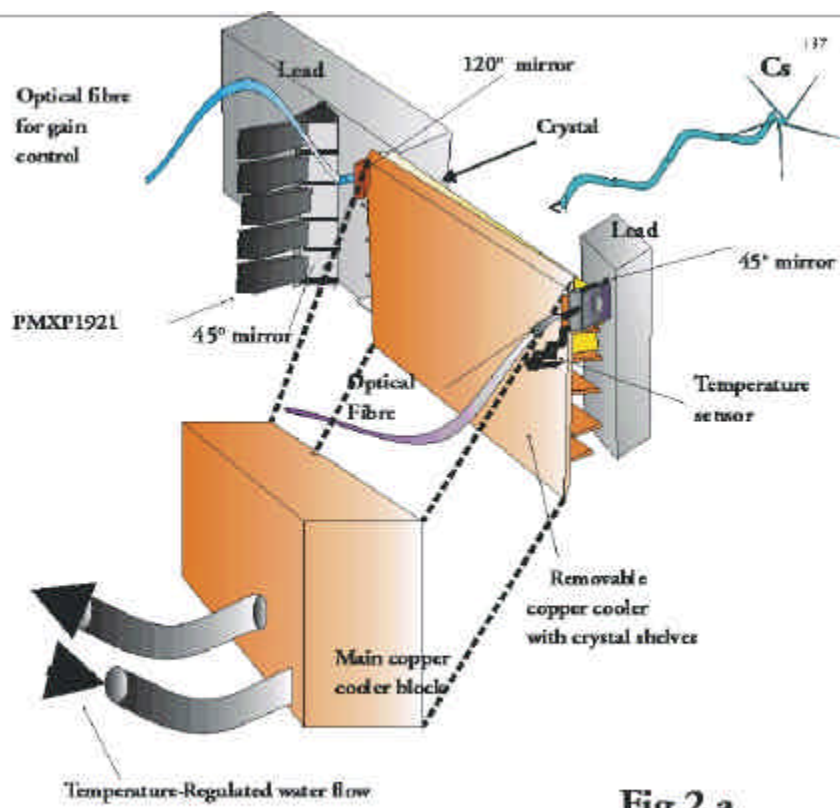
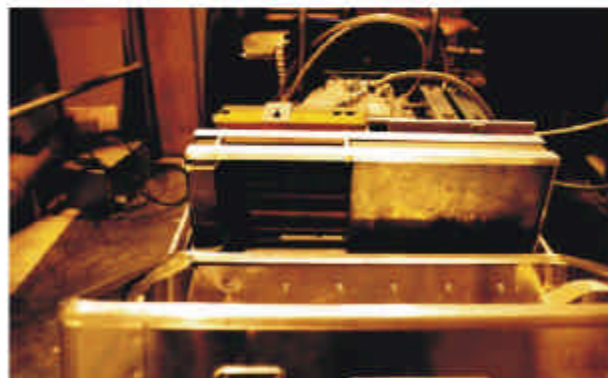
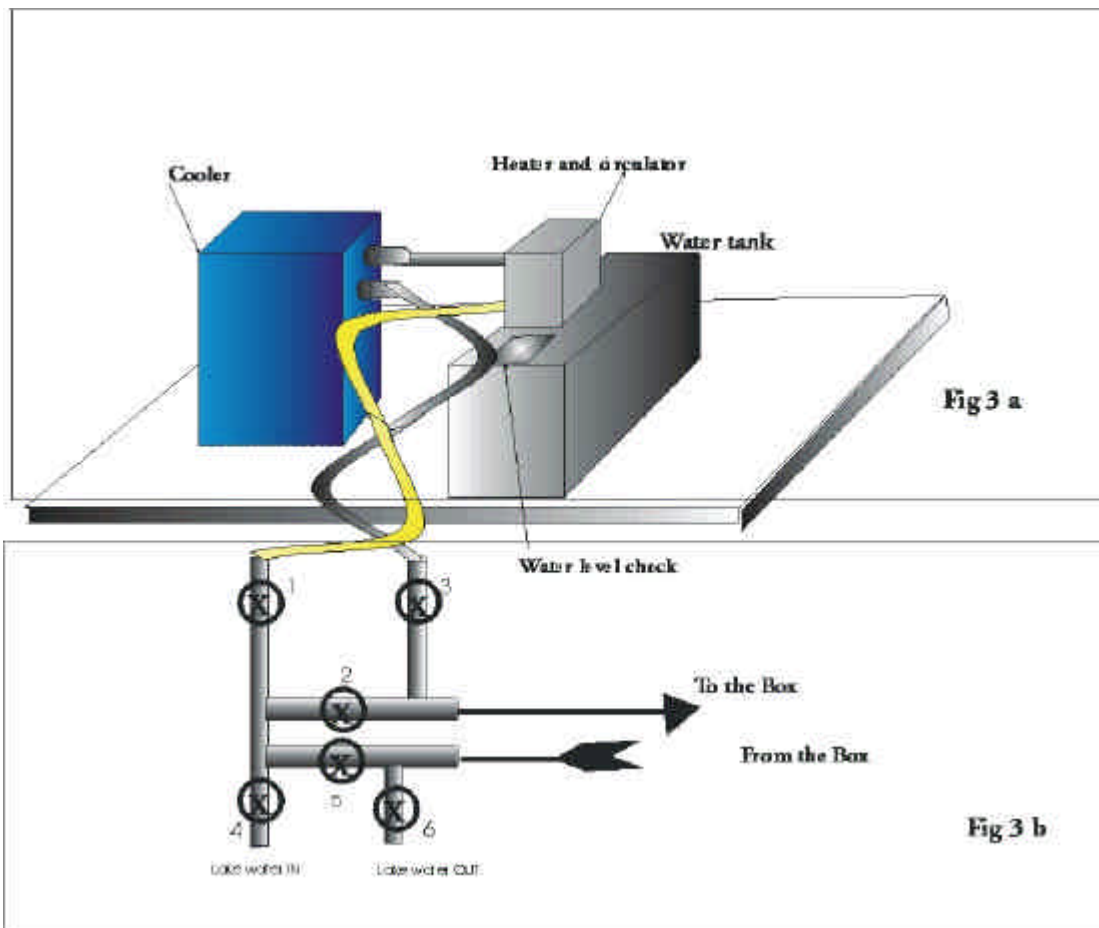


Fig 2 a



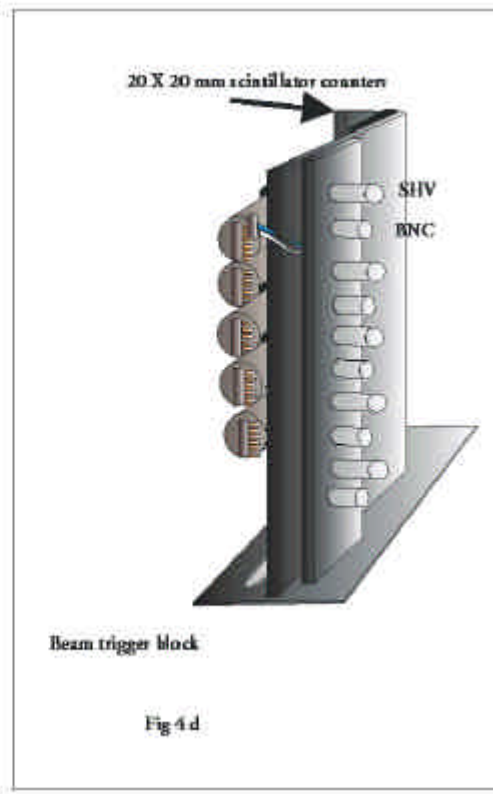
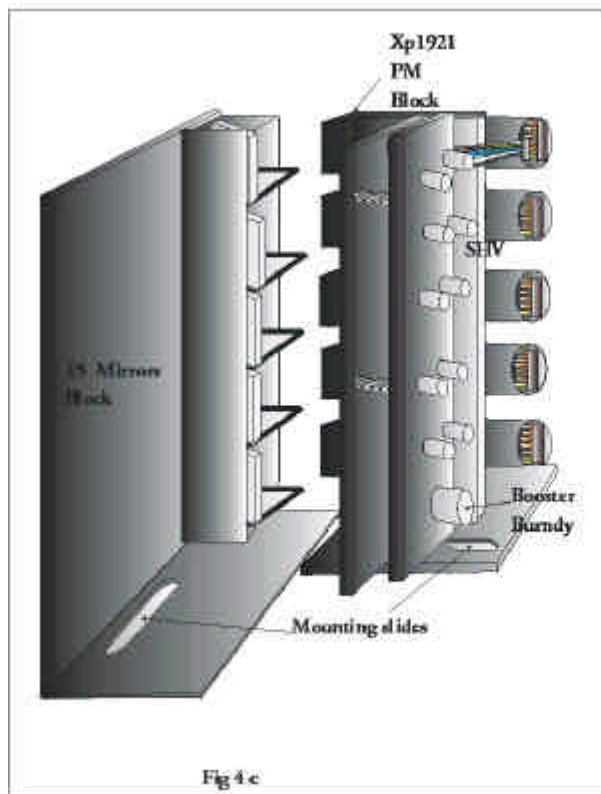
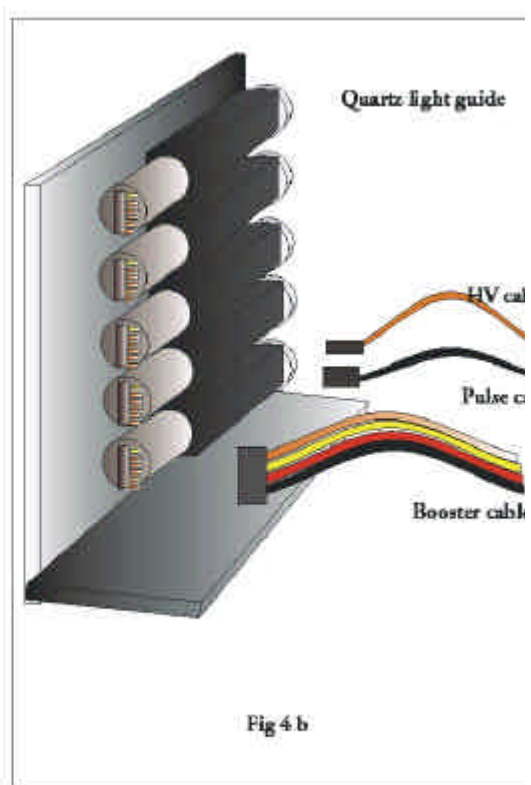
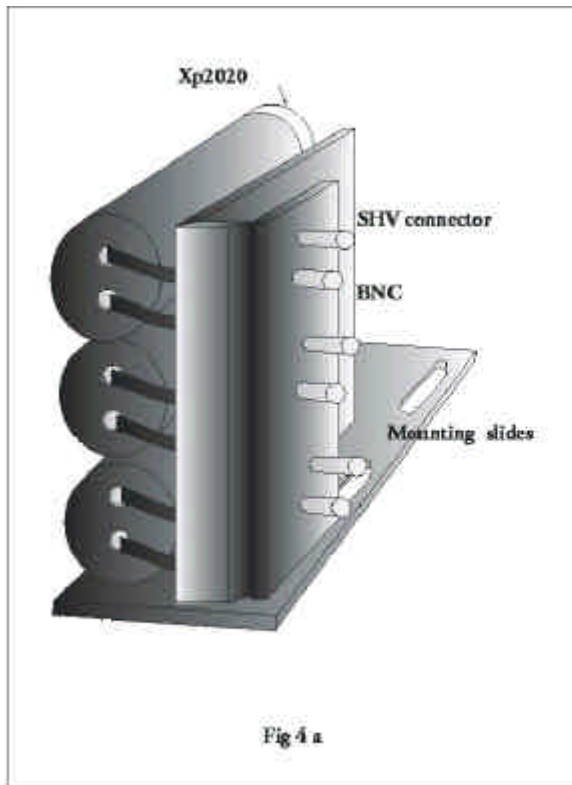
Fig 2 b





		X	Cooling valves status					
		O	1	2	3	4	5	6
I	To flow away the air and to fill the tank		X	O	O	O	X	X
II	To fill the cooler and to flow away the air in cooler		O	X	X	O	X	X
III	Circulation with regulation from the tank		O	X	O	X	O	X
IV	Cooling by external water supply		X	O	X	O	X	O

Fig 3 c



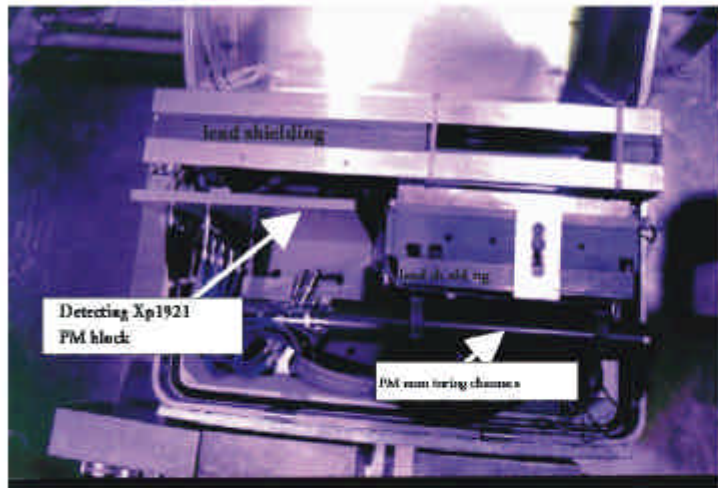


Fig 5 a

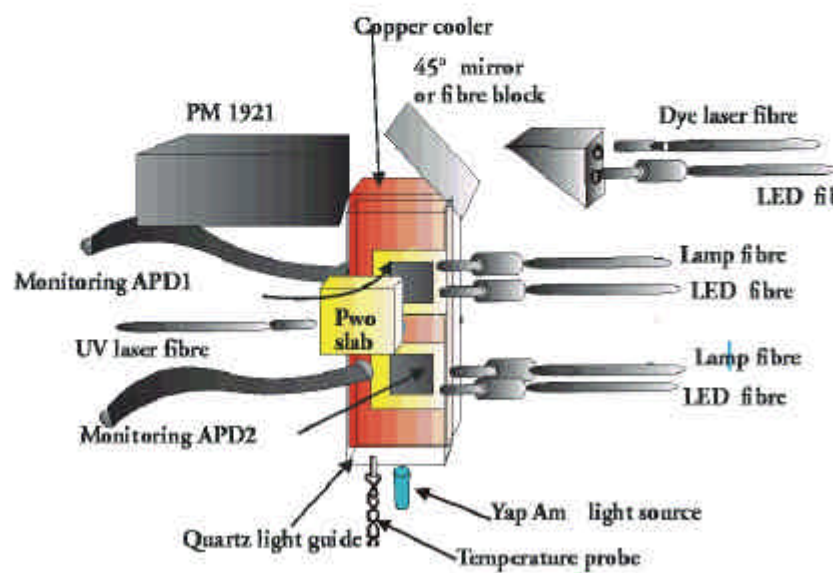
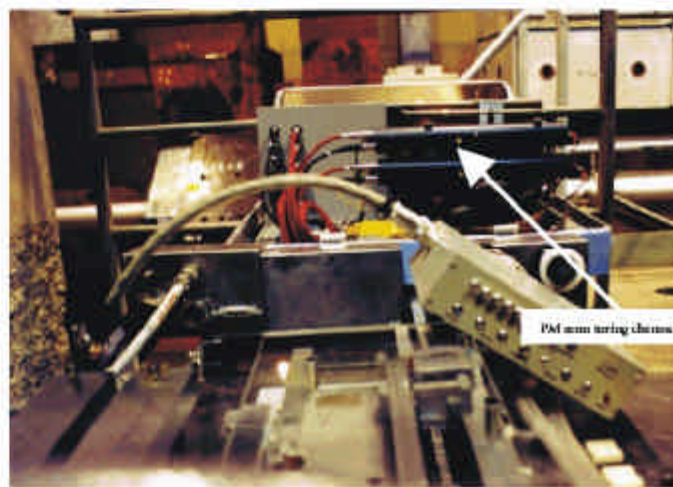
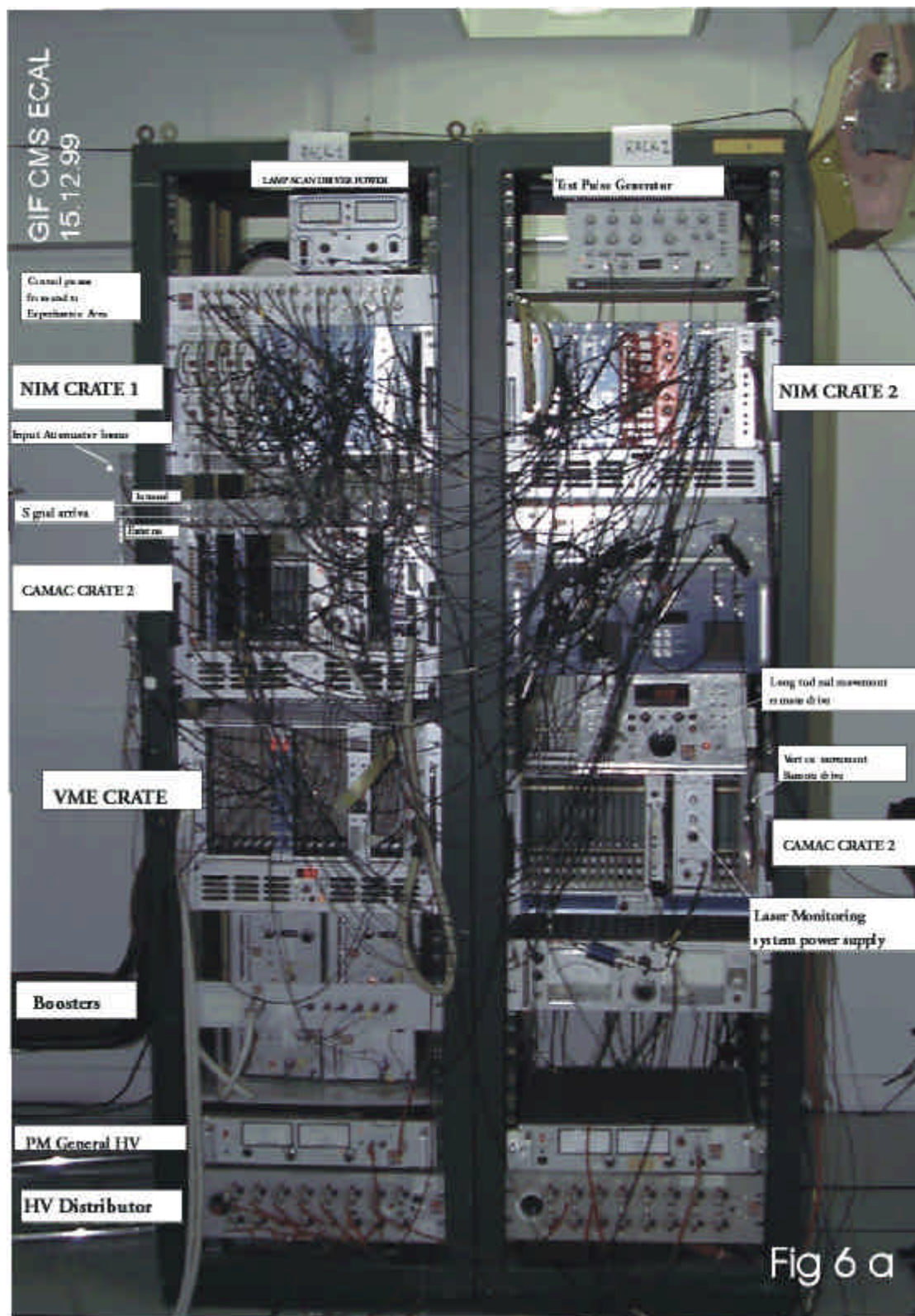


Fig 5 b



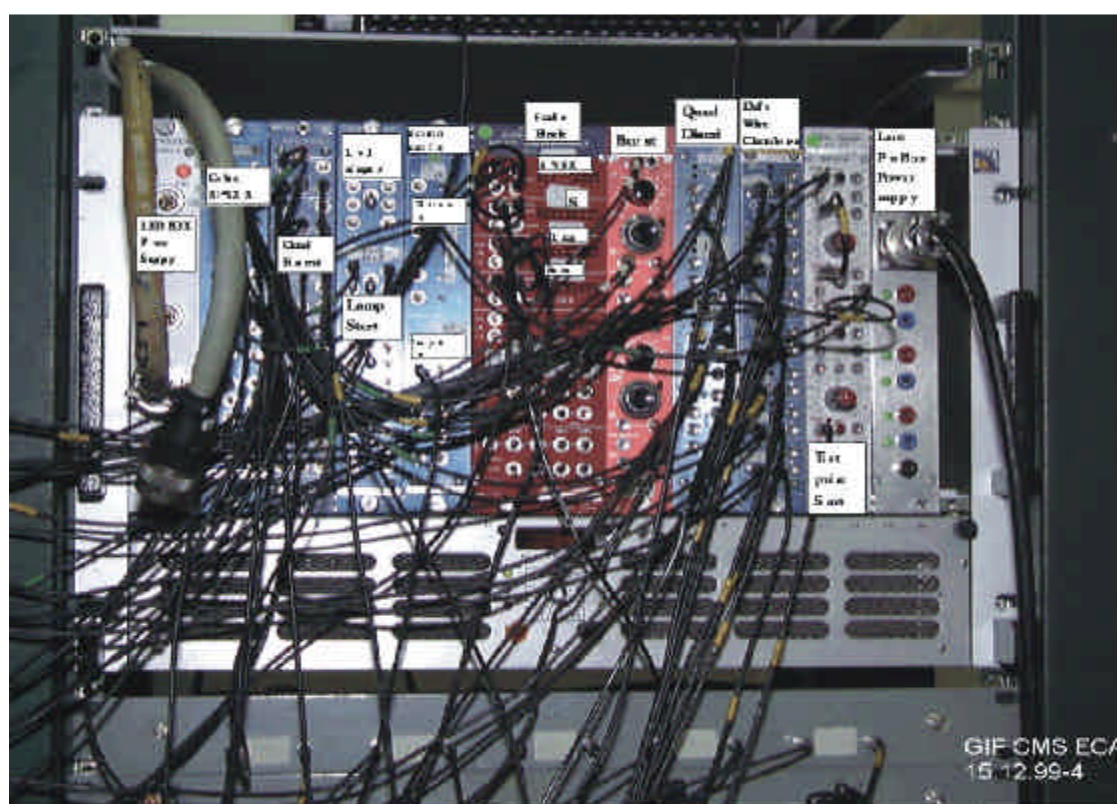
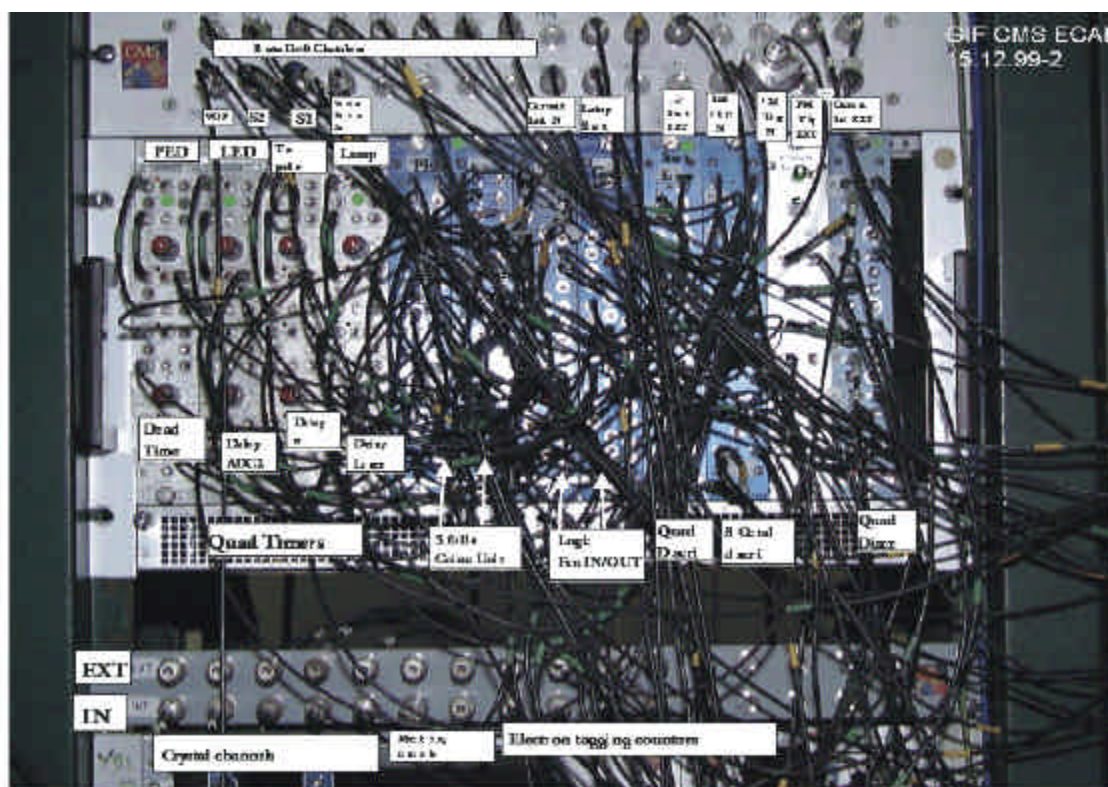


Fig 6 b

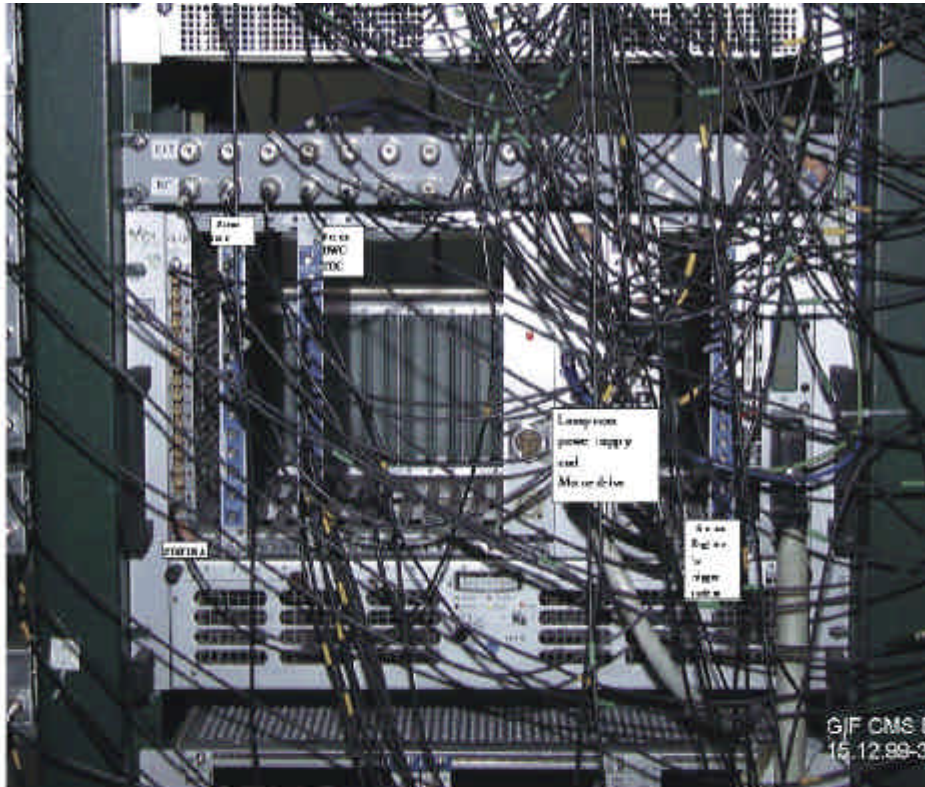
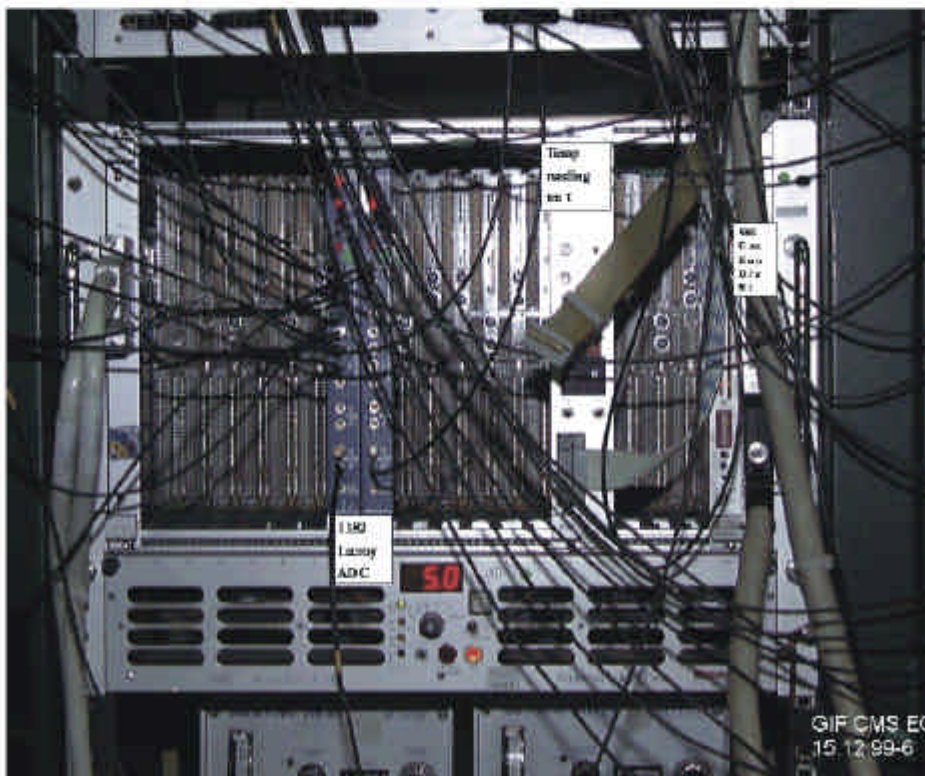
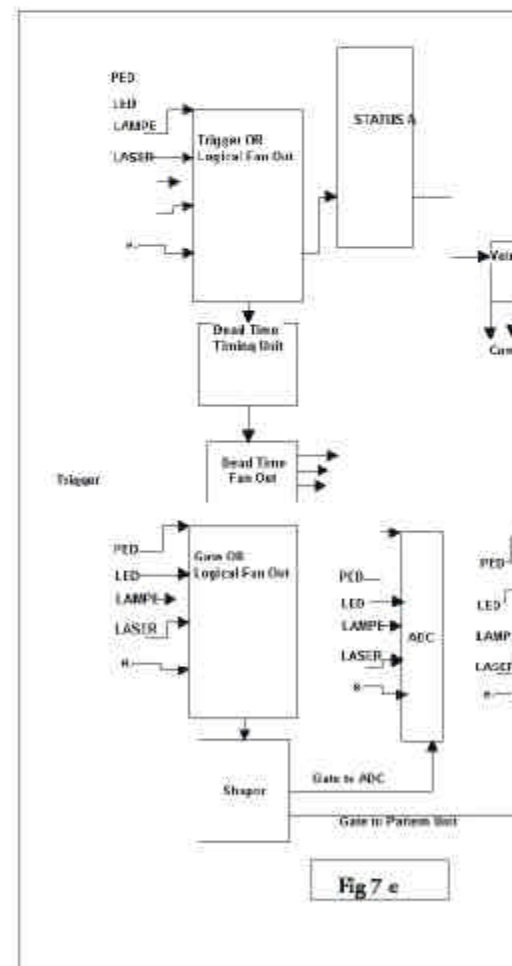
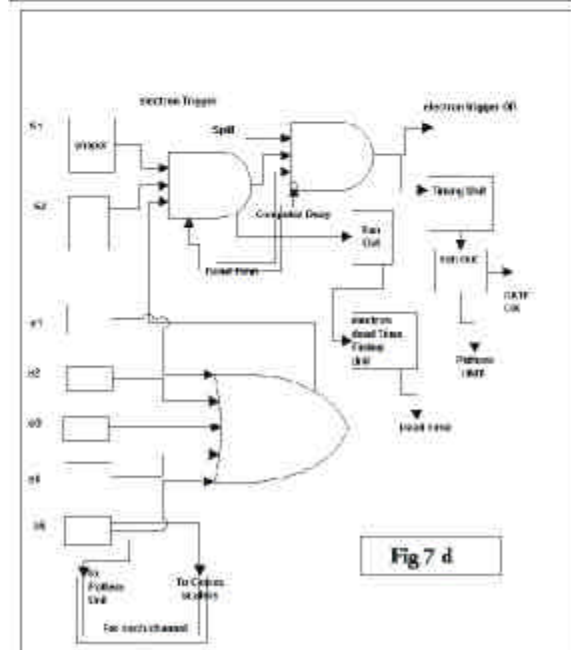
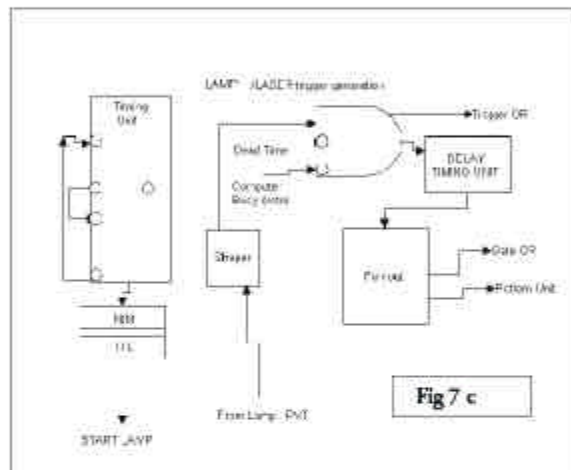
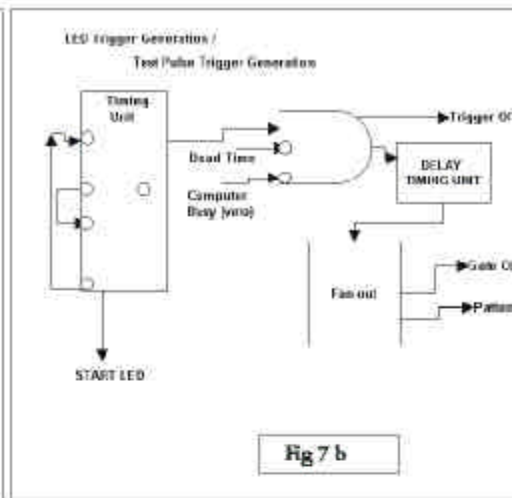
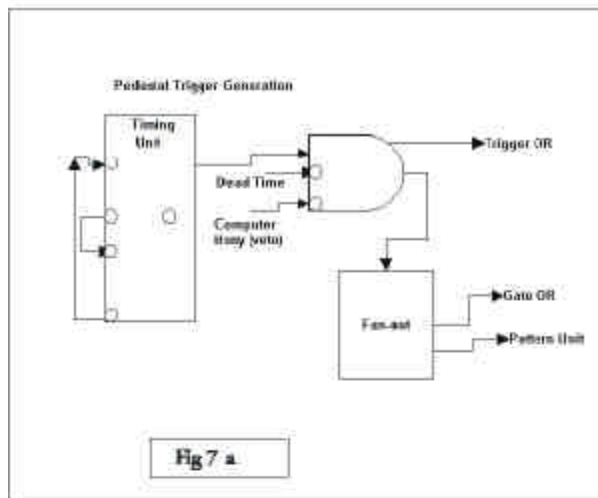


Fig 6 c

CAMAC CRATE 1



VME CRATE



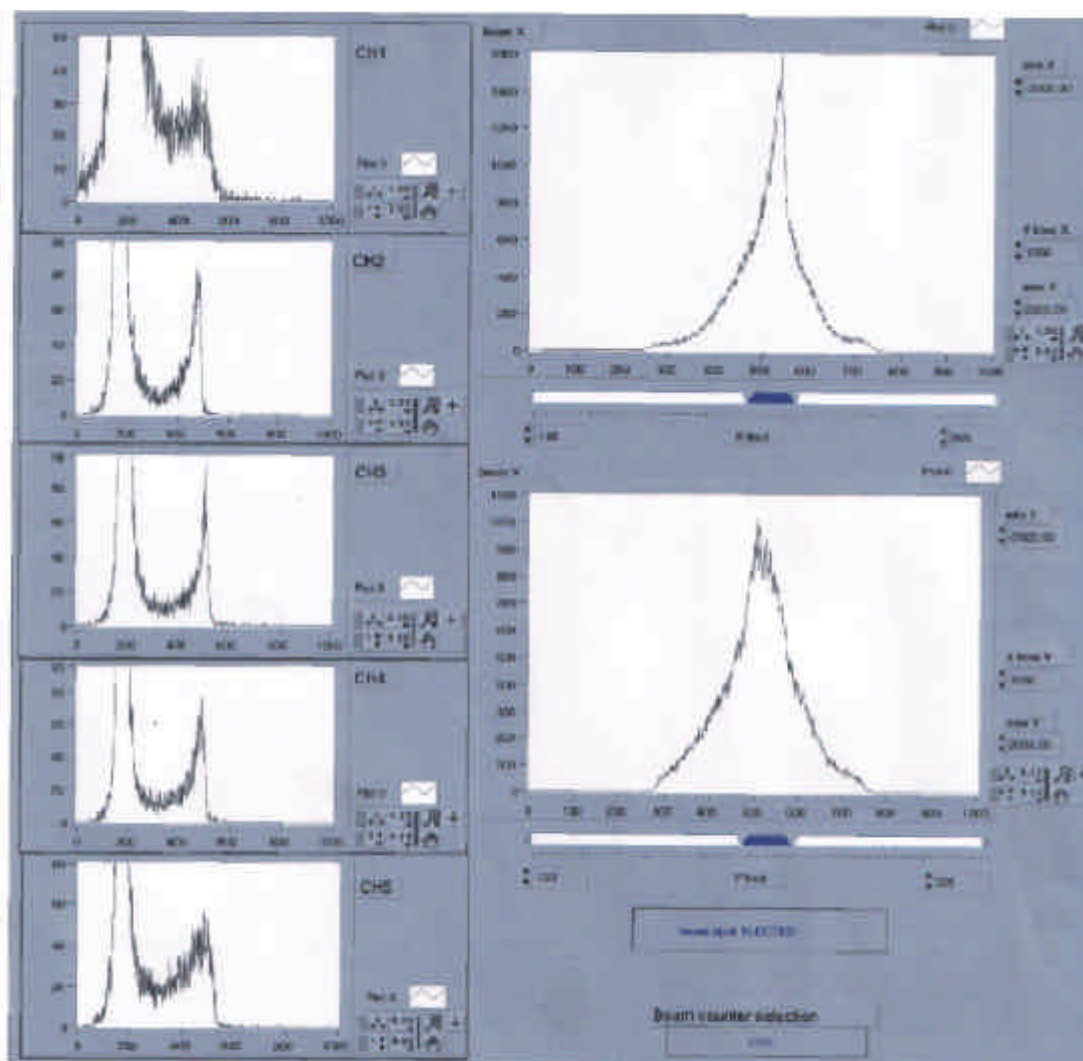


Fig 8 c

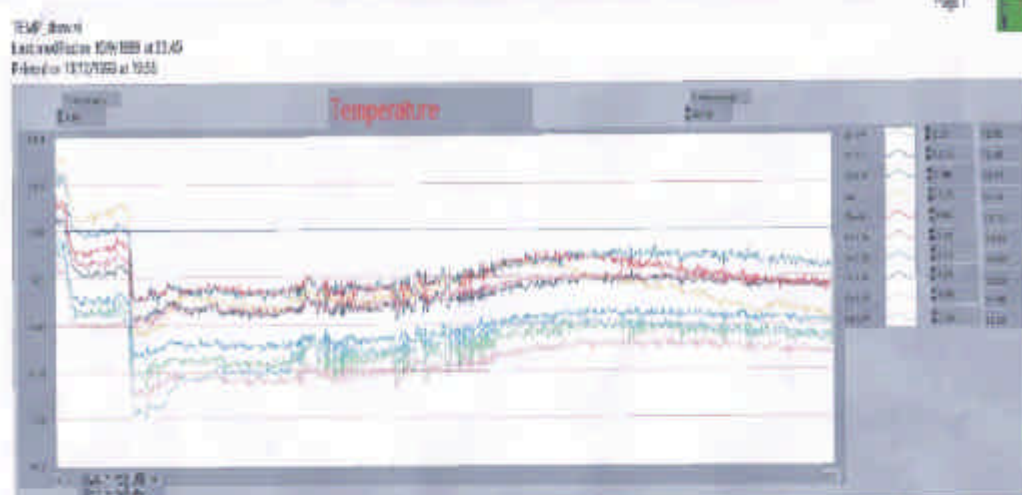


Fig 8 d

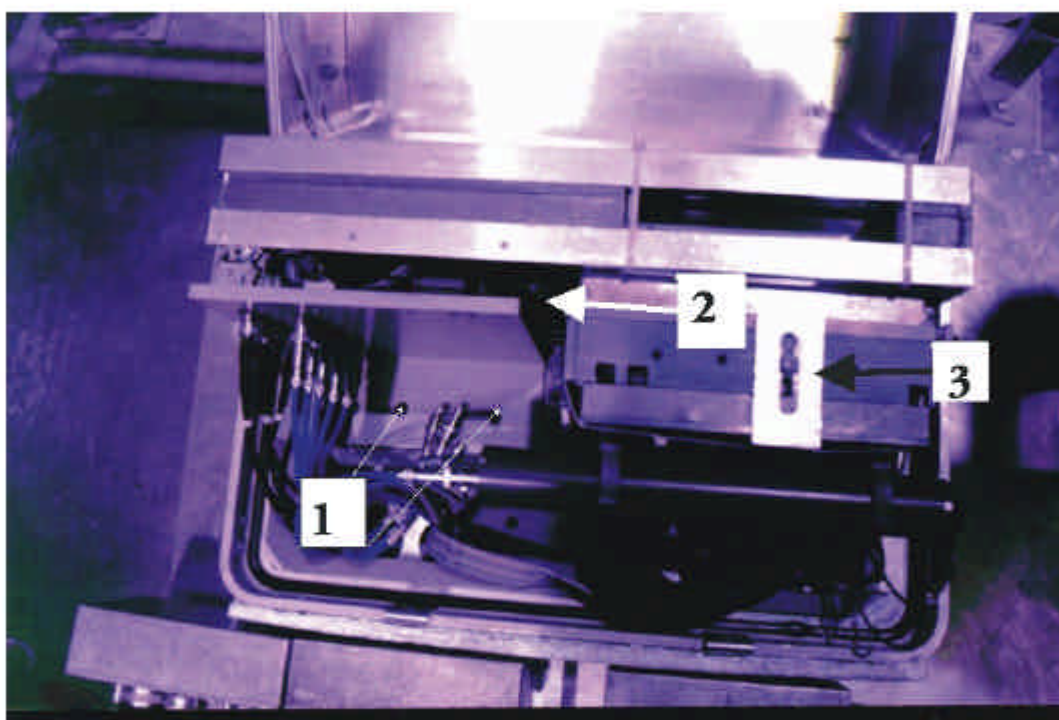
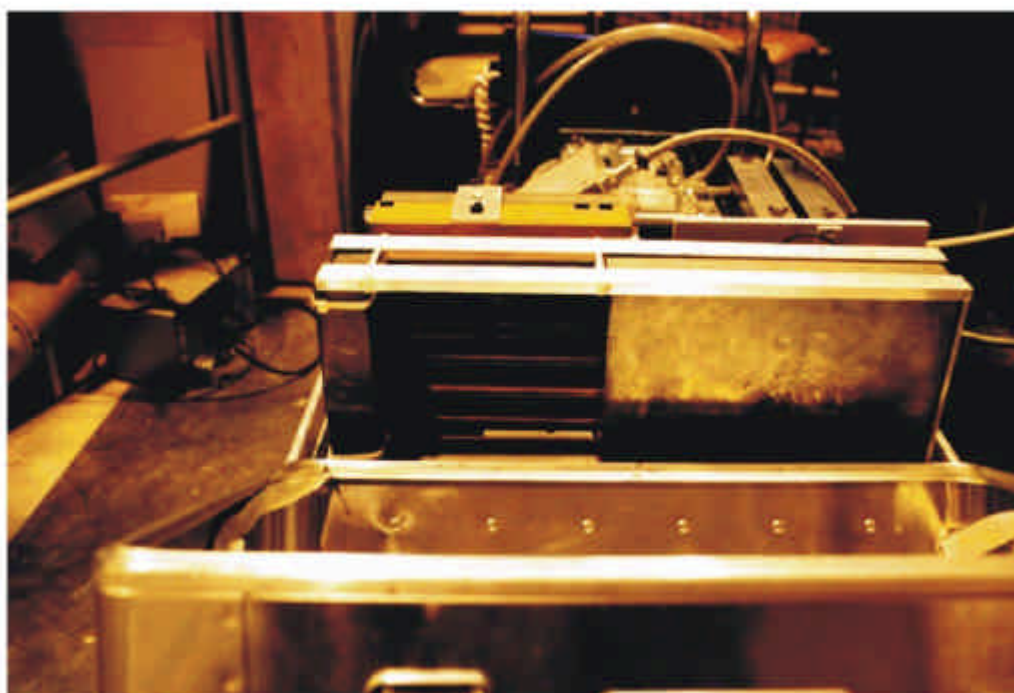
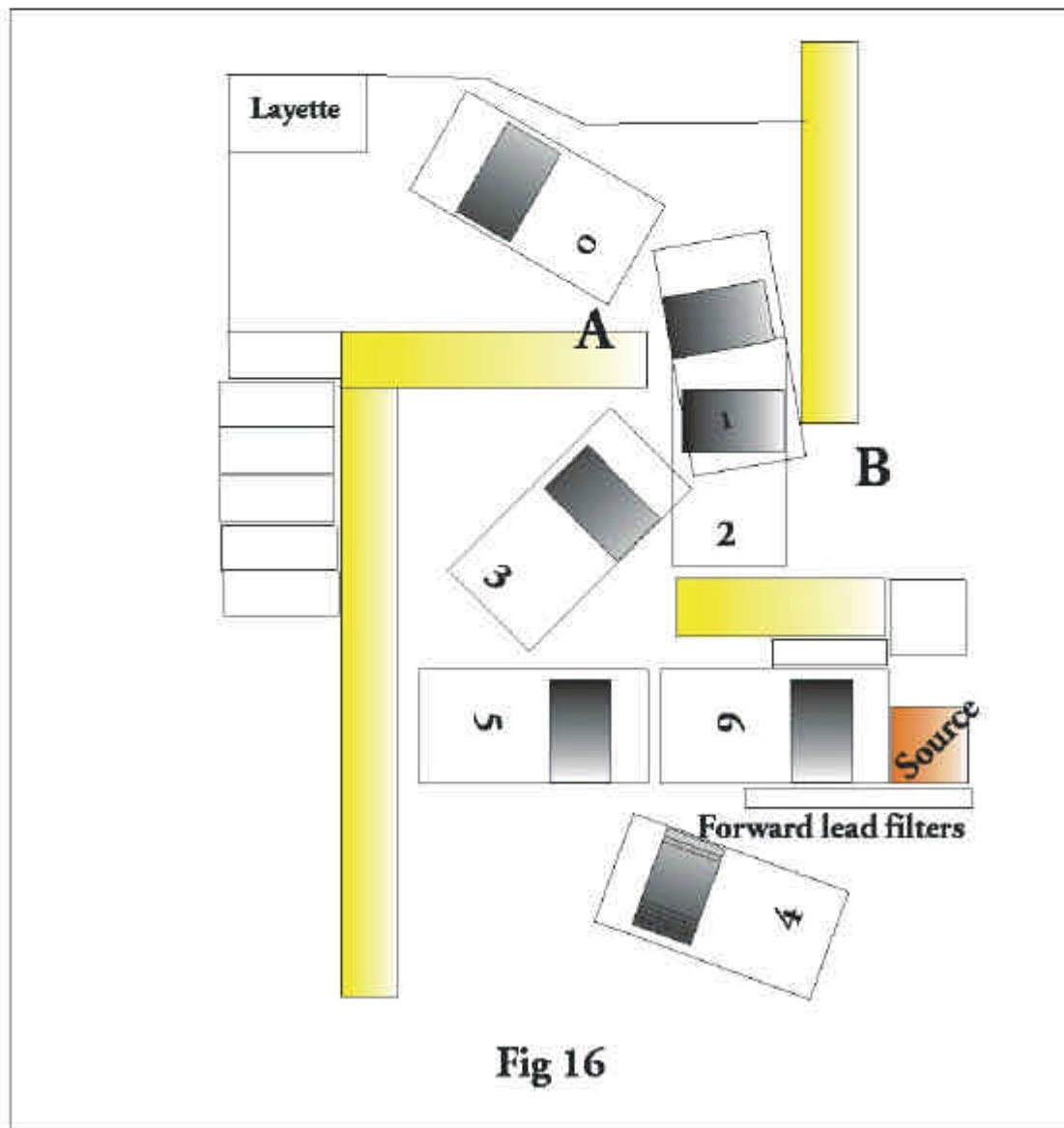
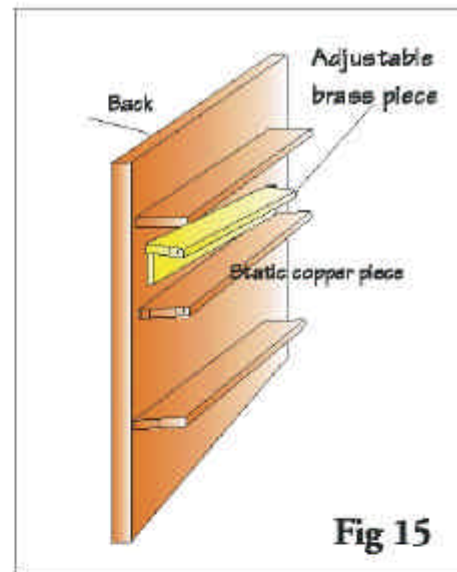
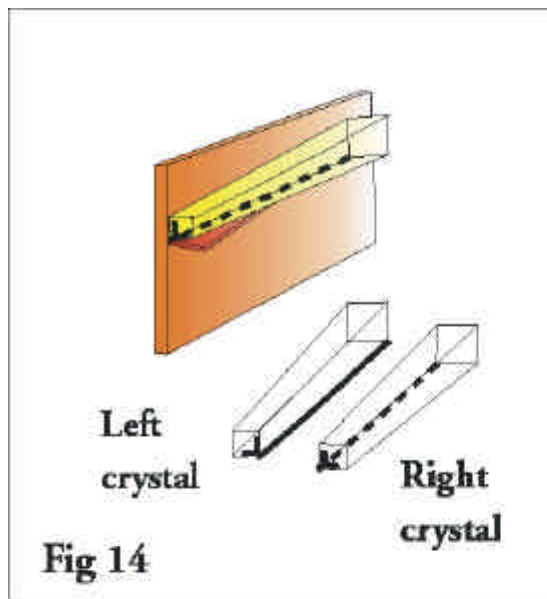
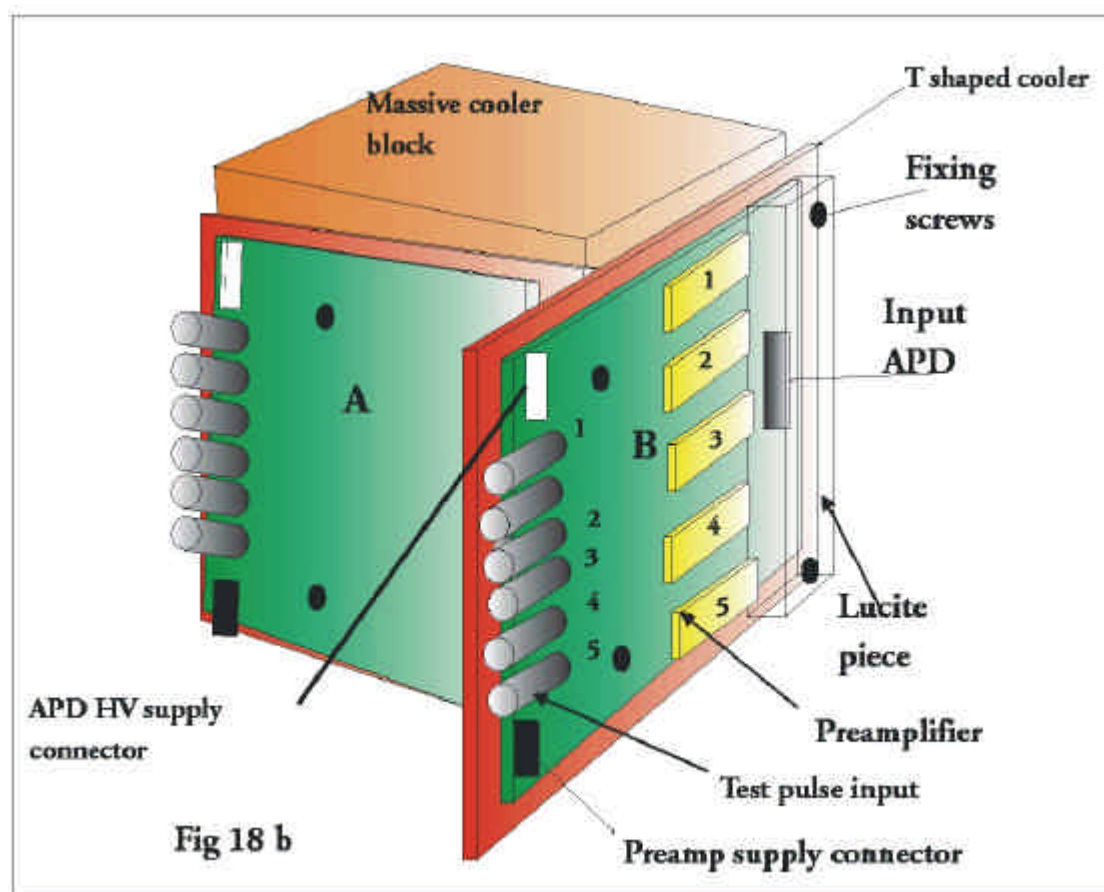
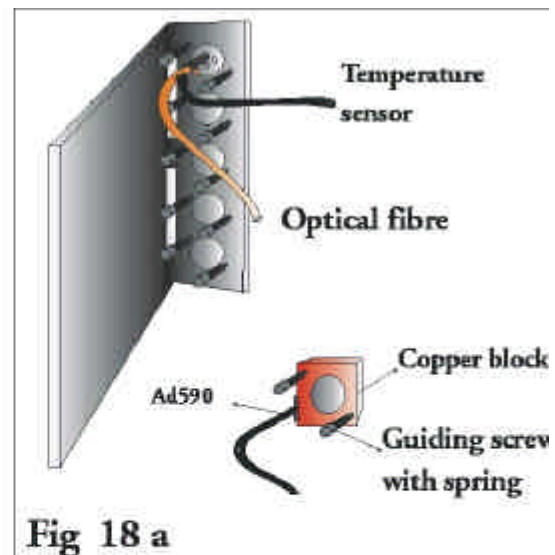
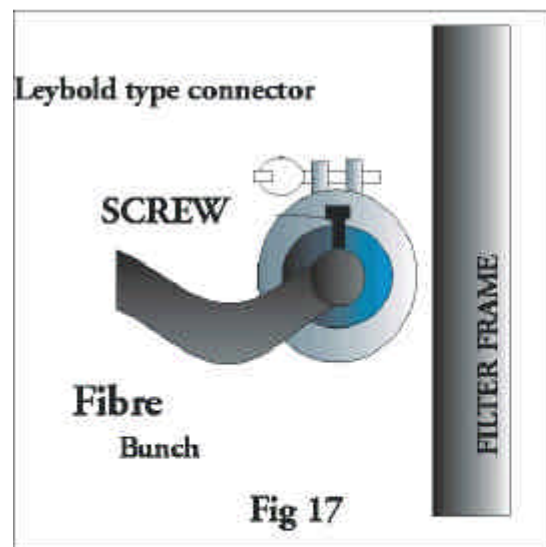


Fig 11







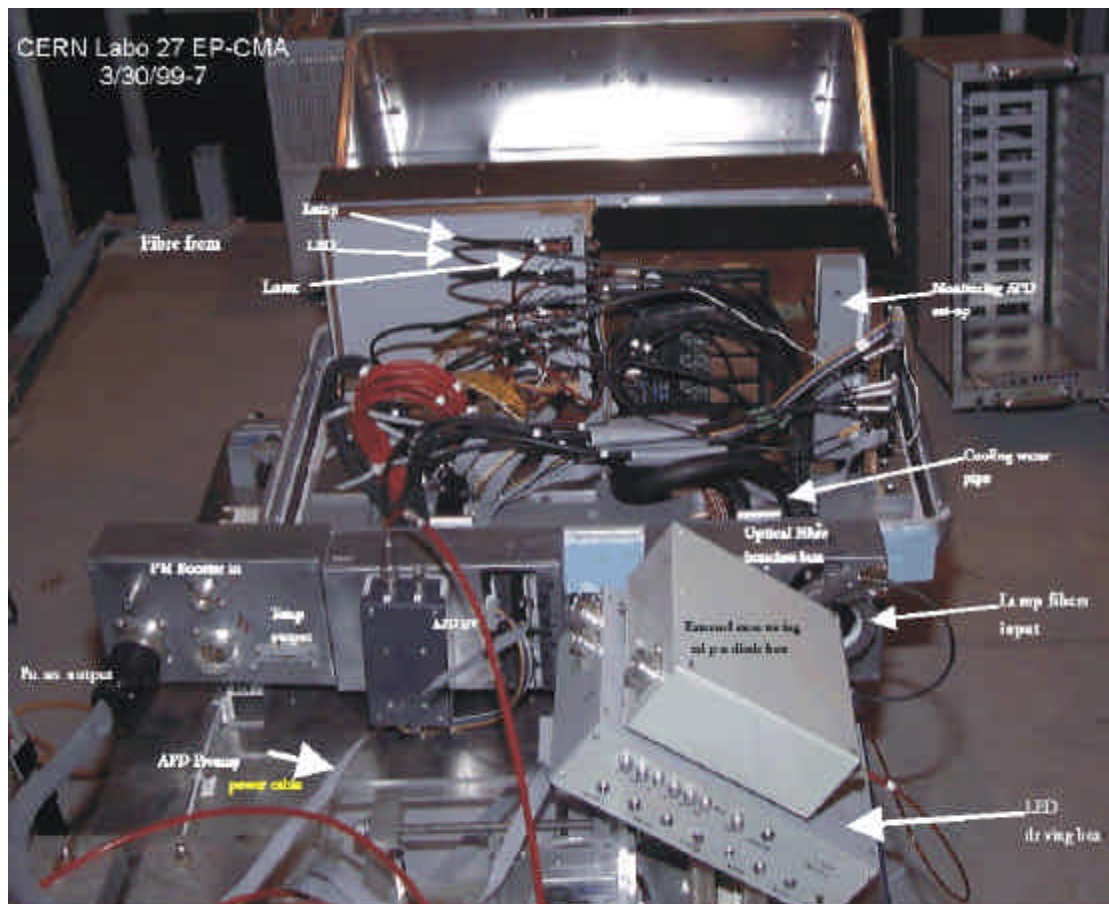


Fig 18 d

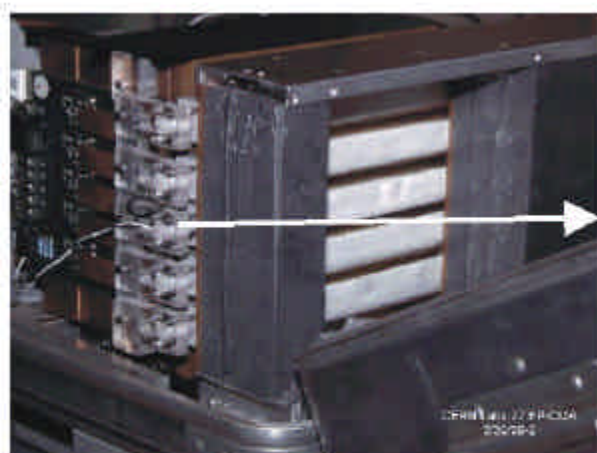
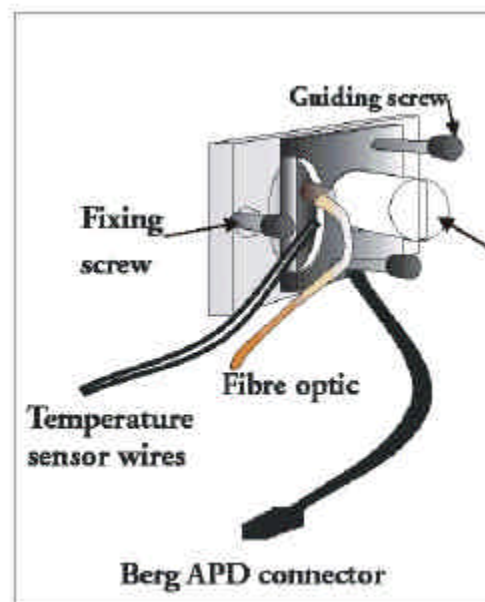
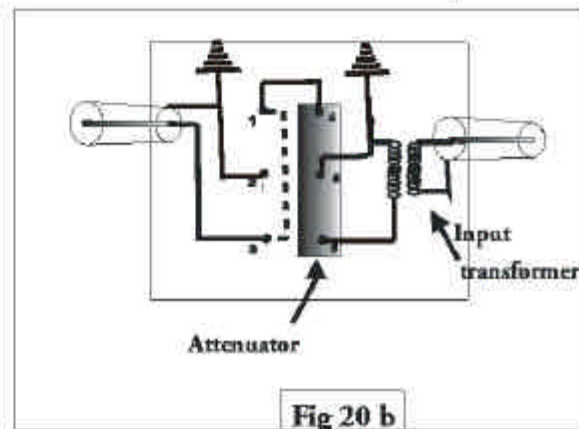
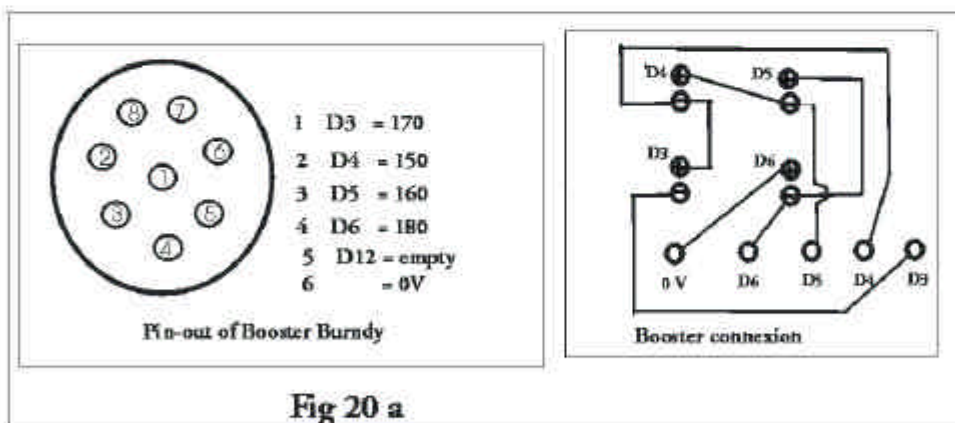
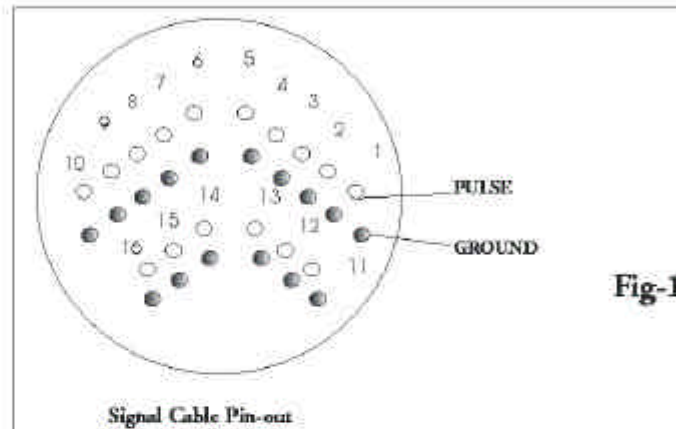
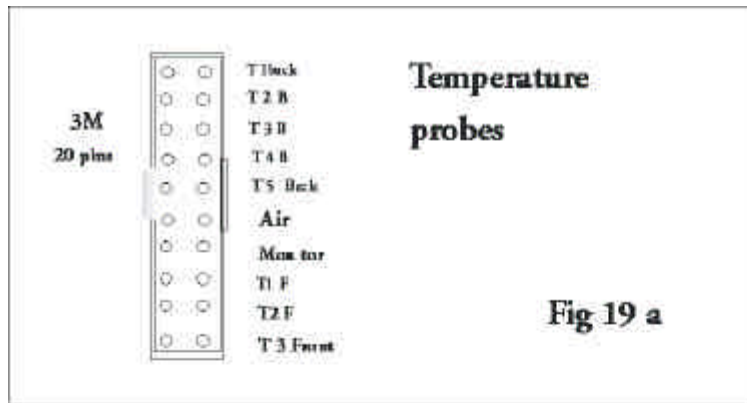


Fig 18 c





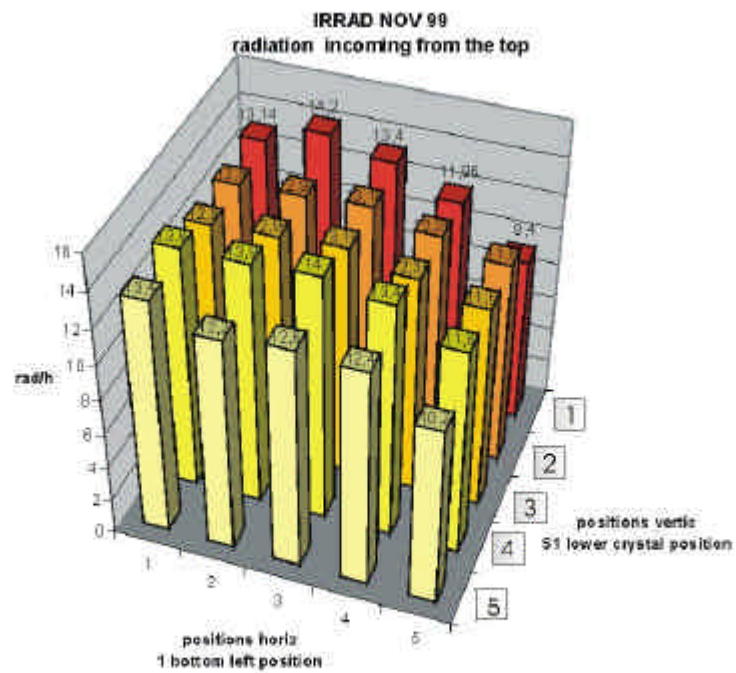


Fig 21 a

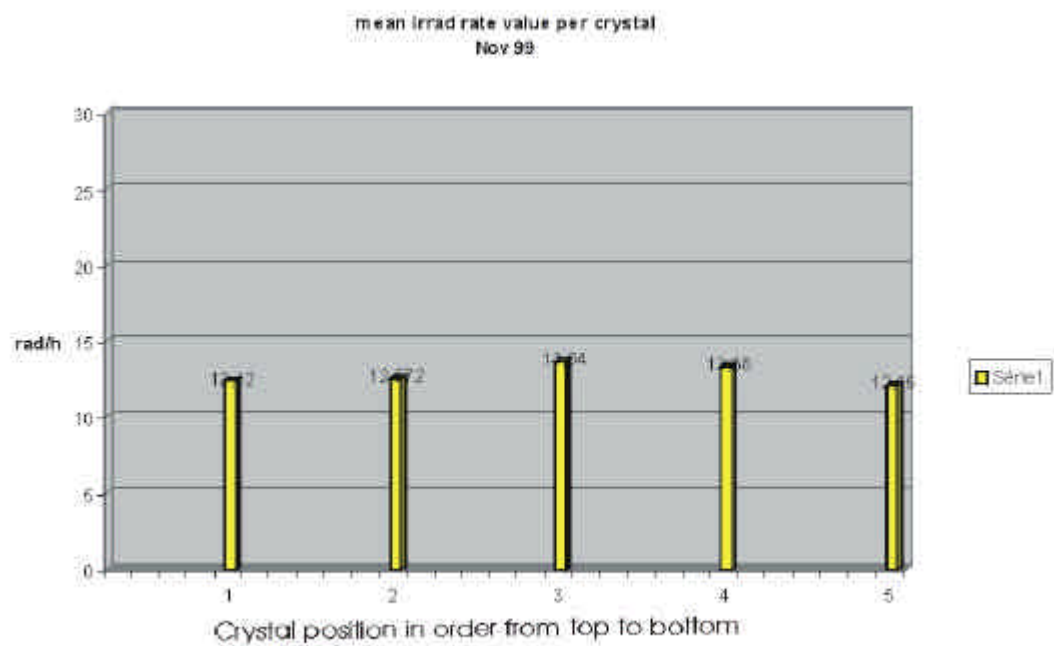


Fig 21 b

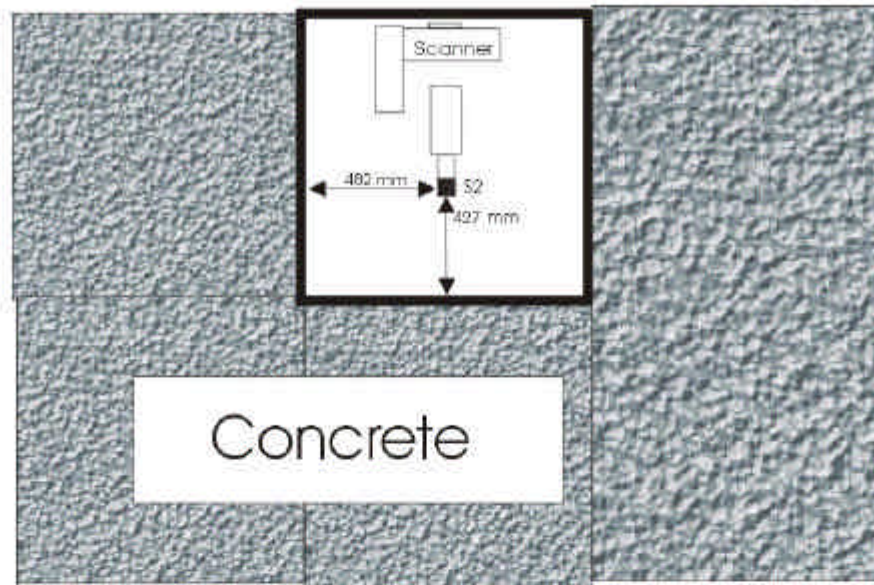


Fig 22 a

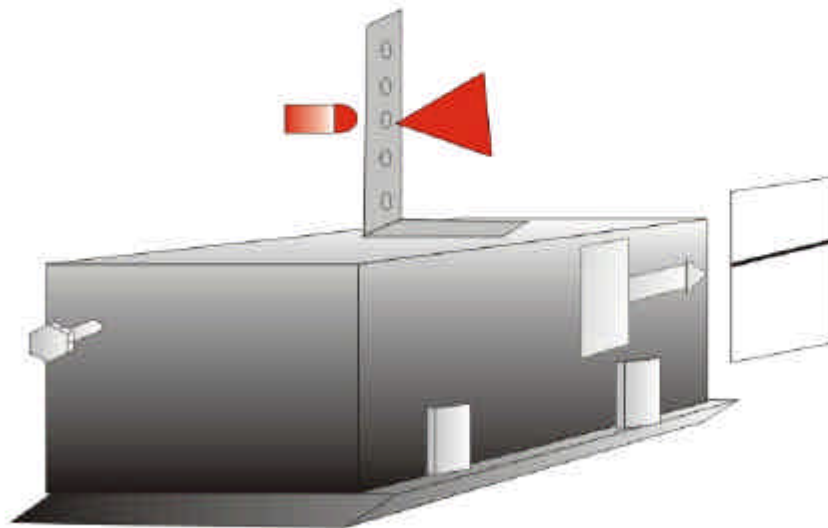


Fig 22 b